ANOTHER BOOM FOR AMAZONIA? SOCIOECONOMIC AND ENVIRONMENTAL IMPLICATIONS OF THE NEW CAMU CAMU INDUSTRY IN PERU

By

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A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

2004

ACKNOWLEDGMENTS

My sincere thanks goes to the residents of rural communities in Peru and Colombia who generously spent time sharing their knowledge and showing me their lands while I was conducting this research. I am also grateful to the many people in the towns and cities of Peru, Brazil and Colombia who assisted me with this research. In particular, my gratitude goes to the people of the Putumayo, Ucayali, Tahuayo, and Nanay Rivers; and the people of Iquitos, Pucallpa, and Manaus.

I want to thank the members of my doctoral committee, Drs. Nigel Smith, Abe Goldman, Hugh Popenoe and P.K. Nair for their valuable contributions and support during this process. Much of the inspiration for my work came from the courses they taught. I also thank Dr. Edward Malecki for his support as a committee member before he left the university. Though not on my committee, I am grateful to Drs. Timothy Fik and Jack Putz for their assistance

I want to thank Matt Marsik and Brian Becker for help with the maps. Justino Llanque and Paul Losch provided extraordinary and generous help with library needs. Matt McPherson, Kristen Conway and Oliver Coomes gave helpful suggestions and support during this process. I also want to thank the following individuals and institutions for their interest and assistance: Mario Pinedo, Pilar Diaz, Juan Garcia, Diana Perez, Antonio Lopez, Sergio Pinedo, Sixto Iman, Rita Riva, Carlos Santillan, Hector Yamakawa, Jakkar Tello, Kaoro Yuyama, Herminio Inga, César Delgado, Ricardo Farroñay, Dennis Huayllahua, Gerardo Bertiz, Exiles Guerra, Angel Catashunga, Manuel

Tamichi, Jorge Soplin Zuta, Tedi Pacheco Gomez, Luis Moya, Rony Vega, César Reyes, Erika King, Roy Cole, Russell Rhoads, Eric Buhs, Rose Holz, Mark Harkrader, Elsa Rengifo, Julio Ramirez, Filomeno Encarnación, Roldan Torres, Cindy Zehner, Pablo Puertas, Javier Aguilar, Dennis del Castillo, Carlos Rengifo, the Instituto de Investigaciones de la Amazonia Peruana (IIAP), the Instituto Nacional de Investigación Agricola (INIA), the Programa Nacional de Camu Camu (PNCC), the Instituto Nacional de Desarrollo (INADE), the Instituto Nacional de Pesquisas da Amazônia (INPA), the Instituto Nacional de Recursos Naturales (INRENA), the Universidad Nacional de la Amazonia Peruana (UNAP), and the Biblioteca Amazónica in Iquitos. I also thank all of the people who I am forgetting for their kindness and interest in my research and needs.

This research was very generously funded by the Rainforest Conservation Fund of Chicago, Illinois; the Dallas Zoological Society, and the Tropical Conservation and Development Program of the University of Florida. Finally, I wish to thank my wife, Doris, for all her love, patience and support.

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Abstract of Dissertation Presented to the Graduate School
of the University of Florida in Partial Fulfillment of the
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August 2004

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This study examines the socioeconomic and environmental implications of the new camu camu industry in Peru. Camu camu (*Myrciaria dubia*) is a small tree native to wetlands of the Amazon basin. It is especially abundant in Peruvian Amazonia. The high vitamin-C content of the fruit has generated interest in exporting camu camu products from Amazonia to more-developed countries. The government of Peru has been actively promoting this new extractive industry, as well as the planting of camu-camu in rural areas. Non-governmental development organizations and private industry are now actively involved with camu camu projects and enterprises. In Peru, enthusiasm for this native species is high, because camu camu is expected to provide a much-needed and sustainable economic boost for the region. However, many questions about the environmental implications and socioeconomic impacts of the camu camu export industry need to be answered in order to understand its ecological and economic viability, and its effects on business and in rural communities.

Findings indicate that camu camu has provided significantly more income to rural residents than is provided by the traditional boom and bust economies of Amazonia. Households who adopted camu camu as a new crop in their floodplain agroforestry systems farmed significantly more floodplain land than non-adopters, and were especially adept at experimenting with new innovations. Lack of agricultural credit is a major constraint to adopting camu camu as a new crop in Peru. Geographic isolation and the location of processing facilities in relation to fruit harvests present major obstacles to the economic viability of the new industry. Camu camu was found to be cultivated with a higher diversity of annual crops than is typical in floodplain fields of the region. Extraction of camu camu fruits from the wild does not appear to have a negative environmental impact, at least in the initial years of the industry. This non-timber forest product in the process of domestication can support a viable industry in the Peruvian Amazon, if agricultural extension methods and marketing channels are improved.

CHAPTER 1
INTRODUCTION

Camu Camu in Peru

This dissertation explores the patterns of development of an extracted non-timber forest resource undergoing domestication in Peru to supply foreign markets. This resource, commonly known as camu camu (*Myrciaria dubia* (H.B.K) McVaugh), is a small tree native to wetlands of the Amazon basin. It is an important component of riparian vegetation in Peru and Brazil; and is especially abundant in the Peruvian Amazon in blackwater, low-sediment environments (Peters and Hammond 1990). In northeastern Peru, camu camu fruit has traditionally been harvested from the wild and used to prepare beverages. The fruit is a round berry, about 2 to 3 centimeters in diameter (Figure 1-1). The high vitamin-C content of the fruit (Zapata and Dufour 1993) has generated interest in exporting the fruit pulp to be made into products such as beverage concentrate and vitamins (Whitman 1974, Calzada 1980, Clement and da Silva Filho 1994, Peters 1996, Paitán 1997).

Experimental projects with camu camu during the last three decades have now developed into an export industry in Peru's largest region of Loreto and neighboring region to the south, Ucayali (Villachica et al. 1998, Breuer 1999, Picón and Acosta 2000). As a result, demand for the fruit, viable seeds, and seedlings of camu camu has increased; and wild populations of this species are now intensively exploited. Along with Governmental agencies, non-governmental organizations (NGOs) and private industry have implemented many camu-camu projects (Salo and Torres1998, Vásquez 2000, IIAP 2001). Since 1994, a handful of private companies have exported up to 500 metric tons of camu camu pulp annually from Iquitos and Pucallpa via Lima, mainly to Japan (Picón and Acosta 2000). At the same time, domestic consumption of the fruit has increased. An array of candies, jams, powdered drink mixes, vitamin capsules, yogurts, ice creams, frozen preparations, and ready-to-drink beverages made with camu camu have been produced in Peru, promoted mostly for domestic consumption.

Much publicity has been given to this new industry, which many researchers and institutions consider to be an important and long-sought-after economic boost for the region and Peru's fruit export sector (Mejia 1994, Peters 1996, Paitán 1997, Salo and Torres 1998, Breuer 1999, Vásquez 2000). A small "gold-rush" mentality to obtain camu camu has developed because of the limited supplies and short fruiting season of this species. Many rural communities located near wild camu camu stands are now involved in these intense harvests. Governmental institutions and NGOs have promoted the planting of camu camu in the last decade, but almost all of the fruit is still harvested from wild stands, a source of worry for planners who are all too familiar with the damage caused by extractive economies in the Peruvian Amazon (see Peters 1990, Rojas et al. 1998, Vásquez 2000). Rural people living in floodplain environments are expected to be the main participants in planting projects, while they struggle to manage the increased exploitation of wild camu camu from their traditional resource base.

Statement of Problem

The purpose of this dissertation is to explore the environmental and socioeconomic impacts of a non-timber forest resource that is being exploited for a new industry in the

Peruvian Amazon: the camu camu industry. Can specific patterns of exploitation be identified at different scales (i.e., local forests, household, community, and region); and if so, how did they emerge and what determines them? Why are some camu camu forests more damaged by recent harvests than others? Why do some rural households choose to cultivate camu camu, while others appear to have no interest in this species? What is the nature of this extraction and domestication of camu camu, and how does it differ among rural communities and throughout the region? Reports from Peru on the progress of camu camu projects beg such questions, but offer little guidance as to specific patterns of variation or the importance of social and environmental factors that shape how rural people have responded to the new industry.

The lack of information available on these matters presents a problem for planning agencies, NGOs, and research institutions that seek to better understand this resource exploitation and development. My work explores the participation of rural people in the camu camu industry through studies in six different areas of the Peruvian Amazon. Insights gained from one study area serve to inform the others and provide a standard by which our understanding in each can be assessed. The regional focus of the study is an area extending from the Putumayo river basin on the Peru-Colombia border in the north; to the Ucayali river basin in the south, near Pucallpa, Peru. The nature of the regional case study is described later in this chapter.

Research Questions

At issue here are the implications of this new industry for economic development and conservation in the Peruvian Amazon. Will cultivating camu-camu reduce harvest pressure in the wild? The rapid spread of commercial resource extraction in várzea has had a major impact on the people and plants of the Amazon floodplain. At the same time, our knowledge of floodplain conservation and environmental degradation is very limited (Goulding et al. 1996, Padoch et al. 1999). In Peru, there is already reason for concern about increased harvests of camu camu in the wild. For example, fish feed on camu camu fruits (Calzada 1980, Villachica 1996, Paitán 1997), including valuable fish species such as the gamitana (*Colossoma macropomum*). Rural people in Peru suggest that fewer fruits falling into the water have resulted in smaller catches (Penn 1994).

Locals are concerned about the current state of fisheries, and about their access to natural camu-camu stands in the future. Meanwhile, the government has promoted the planting of camu camu on the floodplain as the best way for rural people to benefit from the industry, and for the camu camu industry to sustain itself. Addressing these issues raises the following question: What are the environmental and socioeconomic implications associated with this non-timber forest resource (NTFR) that is being promoted as a new industry in the Peruvian Amazon?

To answer this broad question, a subset of questions was used to identify early trends and patterns that may exist in extraction and cultivation activities. The research questions also examine whether planners and planters are selecting locations that will facilitate the domestication and marketing of camu camu.

- How have rural communities responded to this new industry, where are they located, and what explains the nature of their responses?
- How have the planting programs changed the landscape, and what explains these changes?
- How is camu camu being cultivated in Peru, and what explains the differences in these recently adopted practices?

- What environmental impacts from this industry can be observed in camu camu stands, and what explains the nature of these impacts?
- What initial patterns and trends does the new industry exhibit across the vast area of the lowland Peruvian Amazon, and how does it compare to other attempts to domesticate non-timber forest products in Amazonia?

Conceptual Approach

The conceptual approach taken here emphasizes the evolution of non-timber forest resources from wild, extracted forest resources to domesticated, cultivated species for export markets. This concept recognizes that many patterns and processes of exploitation coexist as cultivation techniques for these resources develop. The relevance of the abundance and proximity of this species to centers of human population in the extraction, cultivation, and marketing processes will help guide the inquiry. To illustrate the dynamic nature of relationships among people, extracted resources, and markets, the domestication of other non-timber forest resources in Amazonia was considered in both the past and present. At the same time this approach recognizes that the camu camu industry has yet to establish itself and is therefore different from non-timber forest resources that supported significant markets for decades or centuries. Furthermore, the presence of plant diseases and pests is a recurring theme in the history of non-timber forest products that have undergone domestication, and camu camu cultivation may encounter similar problems. Thus, the tenuous nature of this emerging industry is especially relevant to the research questions.

Regional Case Study

A regional case study was undertaken that focused on six areas of the Peruvian Amazon with significant camu camu extraction and cultivation activities[1]. I visited 39 villages and 6 towns located in these areas during 2000-2003. My research also involved considerable fieldwork in other communities, and on boats traveling along rivers and lakes. Time was also spent in the cities of Iquitos, Pucallpa, and Lima, Peru. In Colombia, I visited 4 villages, and the town of Leticia. In Brazil, I visited the city of Manaus, along with visits to the frontier town of Tabatinga.

I chose this approach because my years of work in this area of the world have shown me that the regions of the Amazon exhibit internal differences. For example, even neighboring communities may exhibit considerable variability in their occupations or land use practices. In the case of camu camu, preliminary examination of the literature suggested that the fruit varied significantly in importance to the people of the Peruvian Amazon. For example, Vásquez and Gentry (1989) listed camu camu as one of the ten most frequently consumed fruits of the Iquitos area. However, in a survey near Iquitos, Pinedo et al. (1992) compiled a list of the most important wild tree species exploited by people of the floodplain. More than 30 trees were on the list, but camu camu was not on that list. Chibnik (1994) conducted a regional study focused on the livelihoods of floodplain communities, but there was no mention of camu camu. This shows how focusing on just one area or a limited number of communities may give a misleading picture of the region as a whole.

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[1] Camu camu is extracted and cultivated in other areas of Peru, such as in the Río Tigre, Río Tapiche. Río Curaray, and the Río Napo.

This approach was also necessary to test assumptions and hypotheses about geographic location and the local people's involvement with the new camu camu industry. It was also necessary to examine wild stands of camu camu in several areas, not only to determine the effects of extractive activities, but to observe this species in different environments in order to gain an understanding about variations in the size of stands and the morphology of camu camu. Water levels can differ greatly during the year and between years, requiring me to frequently change the location of my research during the study. Peters and Hammond (1990) also noted how the ever-changing water levels make it a challenge to study these oligarchic, riverine forests.

Besides needing to adequately address the socioeconomic diversity and contend with environmental adversity, early findings demonstrated the simplistic extension method of this tree-planting project and the necessity to visit an extensive and diverse group of rural communities that participated and did *not* participate in the PNCC. A total of 16 months of field research was conducted from December 2000 to January 2003.

Study Areas

Regional Geography

The regional focus of the study was spread over an area extending from the Putumayo river basin in the north; to the Ucayali river basin in the south, near the city of Pucallpa (Figure 1-2). Within this vast area of Amazonia, field research was conducted in six main study areas. This consisted of two areas of the Putumayo River, the immediate vicinity of the city of Iquitos, the Tahuayo River basin, the Jenaro-Hererra area, and the immediate vicinity of Pucallpa. These areas were selected because they were located at varying distances from camu camu processing plants and urban markets for the fruit. I found that they were home to a diverse sample of ribereño, colonist, and native peoples engaged in a multitude of economic and subsistence activities.

Most of the study was conducted in floodplain landscapes. Much of the land used for agriculture in the floodplain consists of old river levee fragments of alluvial soil called “restingas,” which may or may not flood on an annual basis. Annual precipitation is 2400-2800 mm at Iquitos; and mean monthly temperatures are 26-28°C (SENAMHI 1997). Oxbow lakes are numerous along the floodplain, as are backswamps (tahuampas). Agriculture is geared toward subsistence, but it is also the most important economic activity in the region (Hiraoka 1986, 1989, Padoch and de Jong 1989, Chibnik 1994, Coomes 1995).

Except for the Pucallpa area, roads are quite rare in this region of Peru. Most people travel in small, 13 to 20 meter river taxis (colectivos), or larger diesel-powered river boats that carry 50 to 120 tons of cargo and passengers. Communities are mostly small villages (caserios) of less than 400 people scattered along the floodplain and where it meets non-flooding uplands.

Upper Putumayo River

This was the most remote of the study areas. I visited two large native communities where The Instituto Nacional de Desarrollo (INADE) had development projects, including camu camu. The villages are officially designated as native, but the people are a mixture of Quechua/Quichua and Huitoto Indians, along with mestizo inhabitants. These communities are located near the infamous Colombian town of El Encanto, once the scene of atrocities committed by rubber barons, and now a large military base (Figure 1-3). Scheduled river boats arrive only twice a year to this area, to drop off and pick up school teachers. The people must find rides with infrequent logging tugs, or development agency boats to take them to the town of El Estrecho downriver. Otherwise, a canoe trip to El Estrecho takes 3 to 4 days.

Middle Putumayo River

This study area centers around the small Peruvian town and district capital of El Estrecho. Of the three communities studied, two were on the Colombian side of the river. One of these communities was native Murui. Two lakes, one on each side of the river, are important sources of camu camu (Figure 1-4). El Estrecho has a military base and an airstrip; and has become a processing center for camu camu. Flights to and from Iquitos in small planes (civilian and military) usually operate from 3 to 4 times a week, but the cost is prohibitive for most people. Occasional boats come up the river from Colombia or Brazil, and take passengers (who can eventually find their way to Iquitos by boat, a process that takes at least 12 days).

Iquitos Vicinity

This study area centers around the largest city in the Peruvian Amazon, Iquitos (Figure 1-2), with more than 325,000 inhabitants (Soregui 2001). Just outside the city, there is extraction of wild camu camu, along with a very limited amount of cultivated fruit. The vicinity of Iquitos has been, and still is, the main center for camu camu research, development, processing, and consumption of the fruit in Peru. Iquitos is the main market for a vast area of lowland Peruvian Amazonia, but is only connected by road to Nauta, a small town of minor importance. Boats take people from several ports in the city to outlying settlements. Pucallpa is a 5 to 6-day trip upriver by boat from Iquitos, while Leticia in Colombia is a 3-day trip downriver. Plane service from Iquitos takes people to these cities, as well as to Lima and Tarapoto.

Tahuayo River – Muyuy Islands

This area is home to more than 20 villages participating in camu camu cultivation, and also contains an important area of extraction on the upper Tahuayo River (Figure 1-5). This is the area of the large CASPI extension project managed by CARE-Peru. All villagers in this area can reach the city of Iquitos by river taxi within 1 day. I studied 22 villages in this area.

Jenaro Herrera and Supay-Sahua Cocha

This area includes the district capital of Jenaro Herrera, and several villages that extract camu camu from nearby lakes located across the Ucayali River. Supay and Sahua Cocha are two adjoining lakes (referred to hereafter as Supay-Sahua Cocha) that at first supplied most of the camu camu for the new export industry. Processing barges have visited the lakes for several years to buy camu camu, and the locals in this area also cultivate camu camu (Figure 1-6). Residents travel to Iquitos by large river boats, a journey of approximately 24 hours. Boats are available about 3 days a week. I studied 5 villages and the town of Jenaro Herrera in this area.

Pucallpa Vicinity

This study area centers around Pucallpa, the second largest city in the Peruvian Amazon. Pucallpa has over 200,000 inhabitants (CTAR-Ucayali 2000), is linked to Lima by road (a 2 day under poor conditions), and has daily flights to Lima and Iquitos. The city is home to several industries, including a brewery that processes camu camu fruit into several non-alcoholic products such as powdered drink mixes, juices, and hard candy. Since there is no wild *M. dubia* in this area, most of the fruit must come from nearby farms, or very distant sources of wild fruit located in the province of Loreto. Unlike Loreto, the area experiences a pronounced dry season between May and September, when only 50 – 70 mm of rain per month falls, and average annual precipitation is 1400 - 1700 mm (Gentry and Lopez-Parodi 1980, Riva and Gonzales 1997). Outside of the city, many farmers cultivate camu camu (Figure 1-7). After Iquitos, the Pucallpa vicinity is the second most important center for camu camu research, development, processing and consumption of the fruit in Peru. I studied five communities in this area.

People of the Region

Population

About 880,000 people live in the department (state) of Loreto, which covers almost the entire northeastern Peruvian Amazon (INEI-Loreto 2000). Slightly over half of the population lives in the urban center of Iquitos, with the remainder inhabiting small towns, villages, and single homesteads in rural areas. Bordering Loreto on the south, the somewhat smaller department of Ucayali has about 425,000 inhabitants, with 65% living in the urban center of Pucallpa (CTAR-Ucayali 2000). Precise figures are difficult are to come by, as populations are calculated by district, not individual cities or towns, and the last complete national census figures are from 1993. What has been documented in the last two decades is the accelerating migration of people from the rural areas to the two main urban centers (Iquitos and Pucallpa), as well as rapid population growth in many small towns such as Requena, Nauta, Tamshiyacu, and El Estrecho (Hiraoka 1985, INEI-Loreto 2000, Soregui 2001).

Ethnicity and Identity

Eight-five percent of rural inhabitants of Loreto (Egoavil 1992) and 81% in Ucayali (CTAR-Ucayali 2000) are referred to as ribereños, a quasi-ethnic group of mestizo people of mixed Amerindian and European descent who live along water courses (Chibnik 1991). Ribereños, like Amazonian Indians, have a great knowledge of forest plants, agroforestry techniques, and hunting and fishing methods. Much has been written about the swidden-fallow agroforestry systems of ribereños in Loreto, with emphasis on the native and market influences (Hiraoka 1985, 1986; Padoch and de Jong 1987; Denevan and Padoch 1988; Padoch and de Jong 1989; Coomes 1995; de Jong 1996; Coomes and Burt 1997). Padoch (1988a) showed that ribereños contribute greatly to the economy of the region, and are also responsible for most of the extraction of natural resources.

Despite the persistent use of the term in the literature, these rural inhabitants do not actually call themselves "ribereños." They most often refer to themselves in occupational or class terms such as pescador (fisherman) or chacarero, as chacra is the common name for the plots of land they farm. The advent of the camu camu industry has brought the term camu-camero(a) (individuals who are most dedicated to working with this fruit).

Researchers point to the Cocama-Cocamilla origins of many of these people (Padoch 1988a; Chibnik 1991, 1994), but ribereños have diverse origins, and it is not advisable to make generalizations about their ethnicity. The origin and ethnicity of the

Kokama[2] Indians themselves are still poorly understood (Cabral 1995). Unfortunately, discrimination and repression have caused many of the ribereño people to ignore or deny their true ethnicity. To be called or classified as "nativo" or "indio" is still an insult to most people in Peru. Moreover, the processes of urbanization, especially the migration of young people from rural to urban areas, make it increasingly difficult for these families to preserve their understanding of natural resources such as camu camu.

Camu Camu in the Study Area

There are approximately 65 species of *Myrciaria* in the lowlands of northwest South America (Gentry 1993). Camu camu refers to several species of *Myrciaria*. The most well known of these is *Myrciaria dubia*,[3] which is a small tree 6 to 8 meters in height, characterized by profuse basal sprouting and thin, pendant branches which give the plant a sprawling appearance (Peters and Hammond 1990). It forms extensive oligarchic and monotypic forests along water courses in Peru. These wild stands of *M. dubia* produce a prodigious amount of fruit (to be discussed in Chapter 2). The fruit is a round berry about 2 to 3 cm in diameter (Peters 1990). *Myrciaria dubia* is often referred to as a bush (camu camu arbusto), or as the small species of camu camu (camu camu pequeño). The other species of camu camu are larger trees with straight trunks, rather than the bush-like *M. dubia*. In Peru, these species of *Myrciaria* are still in the process of identification, and often referred to simply as camu camu de árbol (the tree form of camu camu) (Villachica 1996, Villachica et al. 1998, Vásquez 2000). Researchers in Peru are also uncertain if *M. dubia* is in fact the only species of the smaller, bushy camu camu[4].

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[2] Phonetic spelling (Cabral 1995).

[3] *Myrciaria paraensis* is a synonym of *M. dubia* (Villachica et al.1998, Vásquez 2000). Rogers McVaugh (1981) has also stated that it is synonym of Psidium dubium.

[4] Mario Pinedo, IIAP, personal communication 2001.

At least three species of camu camu were found in this study. All might be called simply "camu camu" by the locals, but three distinct species were identified. The first was *M. dubia*, the topic of this dissertation, which has already been described. The largest stands of *M. dubia* observed during the study were located in lakes in Colombia along the Putumayo River, such as Tinta Cocha (Figure 1-4)

The second species observed was usually called shahuinto or camu camu de árbol, and grows into very large trees. I observed specimens with trunks larger than 60 cm DBH, and at least 20 meters in height. The fruits vary in size, but are thicker-skinned than *M. dubia*, and less round in shape, with stem-end necks. The fruits usually have 2 or 3 seeds, compared to 3 or 4 seeds for *M. dubia* fruits of the same size. The seeds are slightly smaller and more oval-shaped than the nearly flat seeds of *M. dubia* (Figure 1-8). The fruit is red when ripe, and quite acidic; more so than *M. dubia*, which explains why many locals called it camu camu ácido, or shahuinto ácido. The trees were usually dispersed along floodplain lakes and are also spontaneous in gardens. This species was most common in the upper Tahuayo River. Fruiting usually occurs at the same time as *M. dubia*, (December-February in the Tahuayo); but the tree may go 1 or 2 years without fruiting. When it fruits, production can be abundant or next to nothing.

The third species of camu camu was a tree from 8 to 12 meters in height, having a sweet fruit with a slight vanilla flavor (often called shahuinto dulce). These fruits varied in size, from that of *M. dubia* to very small specimens of 0.5 cm in diameter (Figure 1-9). The fruits formed small bunches, almost like grapes, and turned dark violet when ripe. The seeds were similar in shape to coffee beans, usually one or two in each fruit. The pericarp of the fruit is thicker than that of the other two species, and has a leathery texture. The fruits begin to form in November, but ripen unevenly, often taking three or four months to fully ripen. As with the other tree species of *Myrciaria* found in the study area, fruit production can be abundant or next to nothing. These latter 2 tree species of *Myrciaria* were found mostly as individuals scattered along the floodplain, or in groups of a few trees, but never in large stands like *M. dubia*.

Field Work Methods

Multiple methods were used to gather information in this study, from formal household and market surveys to in-depth interviews and participatory observation. It was also necessary to have extensive informal conversations with my many informants, especially with those who were involved in the often sensitive business aspects of the camu camu industry. Surveys were conducted in fields planted with *M. dubia* (accompanied by their owners, in order to assess the condition of the trees, as well as the patterns of land use associated with this species). Damage censuses of wild camu camu stands were conducted in five areas. Low water levels were required to facilitate this work. These levels are often low during the months of August-September and December-January, but this was not true for much of 2002. Timing of field research was also conducted during months of extraction from wild stands (usually December-January), and of camu camu cultivation work in gardens (usually April-September). I also worked alongside the local people, helping them to harvest, sort, and transport camu camu fruits. In their fields, I helped in the planting and weeding of this species. These work experiences allowed me to gain important insights and obtain information that was not obtained by other methods. Research methods are given in detail as the different aspects of the research are presented in the upcoming chapters.

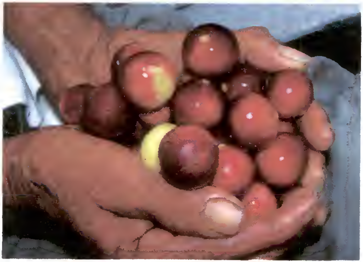

Figure 1-1. *Myrciaria dubia* fruits.

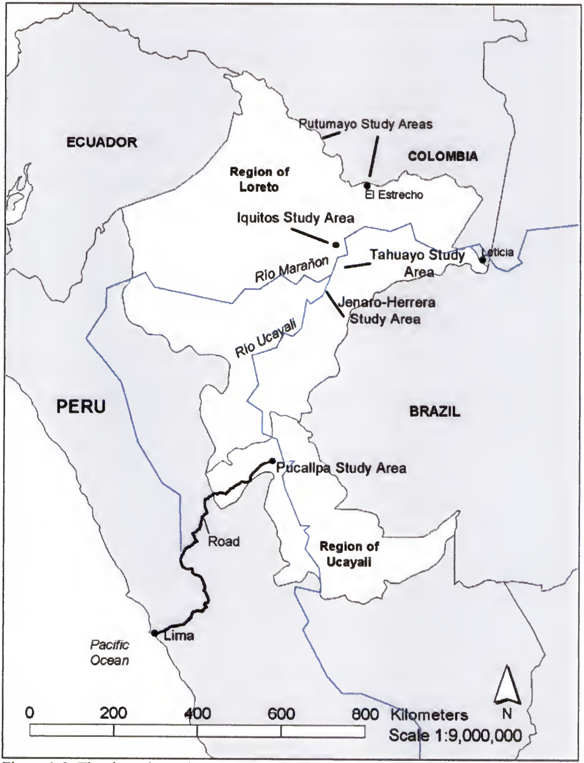

Figure 1-2. The six main study areas.

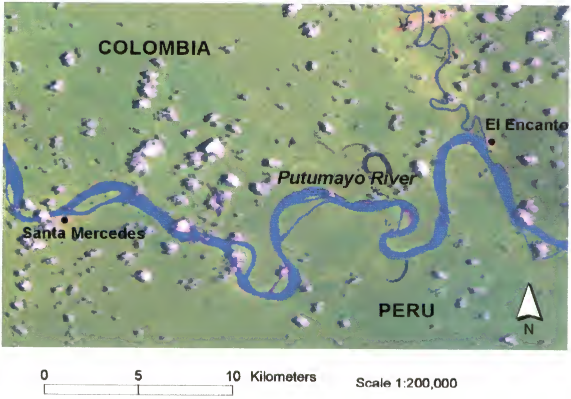

Figure 1-3. The upper Putumayo study area.

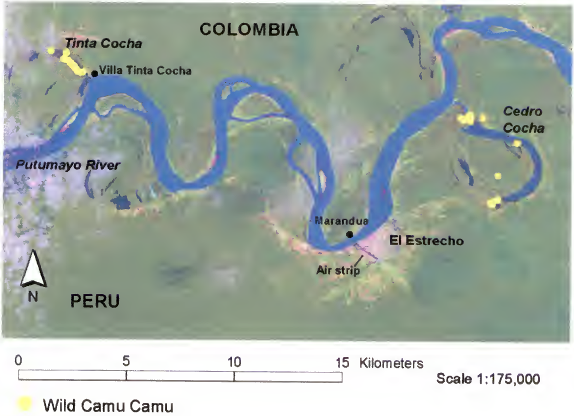

Figure 1-4. Middle Putumayo study area.

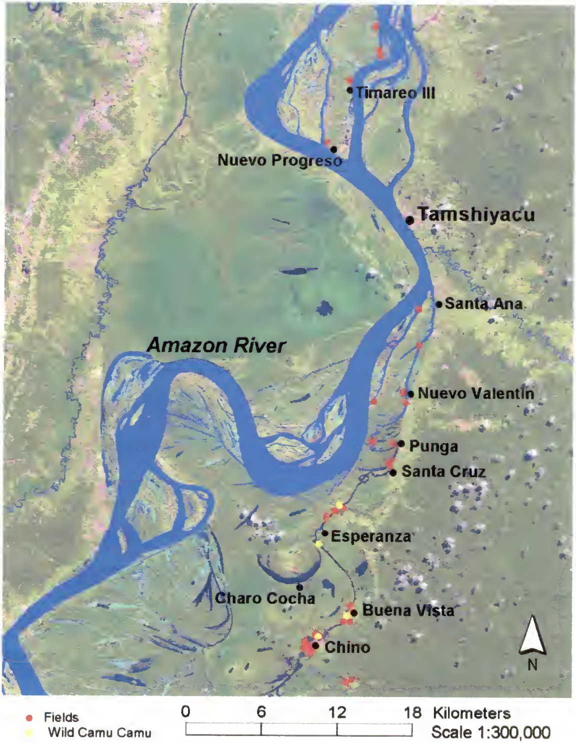

Figure 1-5. Tahuayo River – Muyuy Islands study area.

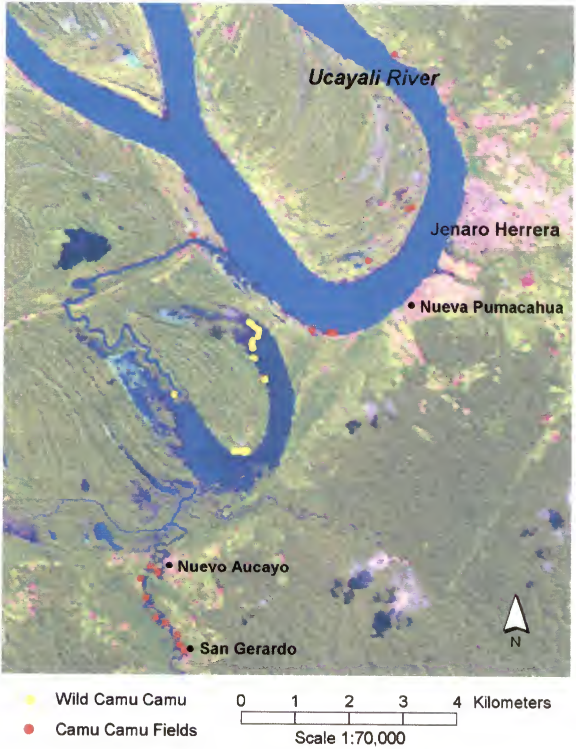

Figure 1-6. Jenaro Herrera and Supay-Sahua Cocha study area.

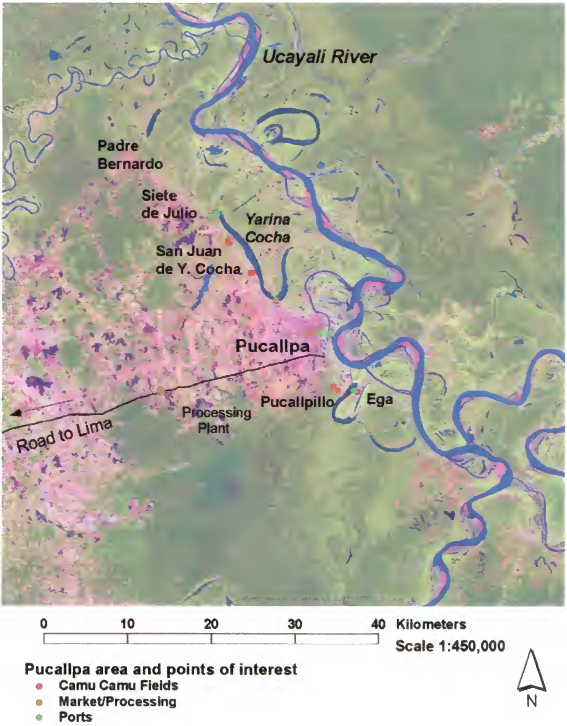

Figure 1-7. Pucallpa vicinity study area.

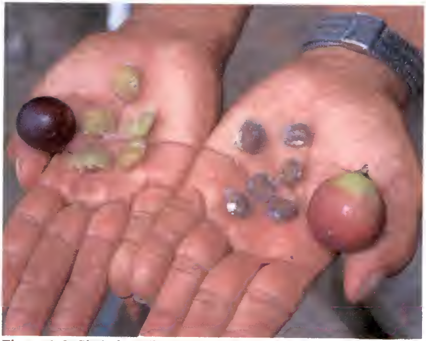

Figure 1-8. Shahuinto (*Myrciaria* sp.) fruit and seeds on right, camu camu (*Myrciaria dubia*) on left.

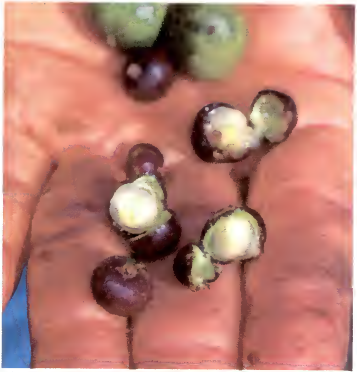

Figure 1-9. Shahuinto dulce (*Myrciaria* sp.) fruits.

CHAPTER 2

PERSPECTIVES ON NON-TIMBER FOREST RESOURCES AND THE CASE OF CAMU CAMU IN PERU

Introduction

Extractive export economies have existed for centuries in Amazonia and serve to characterize the region as one of rapid rises and collapses in economic activity (Moran 1981, Bunker 1984, Barham and Coomes 1996, de Jong et al. 2001). Much attention has focused on the rubber boom and bust of the late nineteenth and early twentieth century (Padoch and de Jong 1990). This period is often described as one of great exploitation and wealth (Collier 1968, Pennano 1988, Stanfield 1998); which despite its prosperity, did not lead to sustained economic development in Amazonia (Barham and Coomes 1996). Besides rubber, we must not overlook the international trade in a multitude of non-timber forest products which have had pronounced and continuing impacts on the Peruvian Amazon, again resulting in little permanent economic development for the region (Padoch and de Jong 1990).

Despite recent innovations in the exploitation of non-timber forest resources (NTFRs) and advances in our knowledge of these species, numerous studies have shown that economies based on these resources are quite limited in their ability to alleviate rural poverty (Nuemann and Hirsch 2000, Wunder 2001). Homma (1992, 1996) presented a model describing the economic dynamics of forest products which demonstrates that the short life span and collapse of extractive economies based on NTFRs is part of a normal, inevitable process. In this context, it seems surprising that Peru would launch a rural development program based on the export of yet another NTFR from Amazonia.

The purpose of this chapter is to explain what may have motivated planners in Peru to implement the Programa Nacional de Camu Camu. What have we already learned about NTFRs in Amazonia and Peru, and what might have caused such an interest in camu camu fruit? What, if anything, makes *Myrciaria dubia* different from other NTFRs and native fruits in the Amazon; or in Peru? How was the exploitation of camu camu supposed to help regional and national economies, or alleviate poverty in rural areas?

In order to answer these questions, it is necessary to review findings from studies of non-timber forest resource use, the conservation of tropical forests, and the viability of these extractive economies. Much knowledge about these issues has been gained in the last decades, but many questions remain (Nepstad and Schwartzman 1992, Nuemann and Hirsch 2000). In this chapter, particular attention is paid to non-timber forest resources in Amazonia, and studies from Peru, as we examine the treatment of NTFR exploitation in the literature. The theoretical treatment of boom and bust economies in Amazonia (Homma 1992, 1996) helps guide the analysis.

The importance of experiences and perspectives within Peru is stressed. Insights offered from these experiences contribute to discussions on the strategies of exploitation, cultivation and conservation of camu camu in Peru. An analysis of these issues in their local setting is necessary to put the study of the new camu camu industry in the proper perspective before presenting most of the results from field research. In this way, the chapter sets the stage for an analysis of the decisions made by development practitioners and rural participants in the new camu camu industry (Chapters 3 and 4).

Evolution of Perspectives: Early History

Anderson (1990b) argues that extractive activities in Amazonia have been poorly understood due to a persistent lack of documentation about the knowledge and use of NTFRs by traditional inhabitants of the region. However, written accounts of these resources and their uses were evident in some of the earliest reports from the Amazon. As explorers penetrated the region, their attention was constantly attracted to the myriad uses and preparations made from non-timber forest resources. These products were collectively called "drogas" or "drogas de sertao" in Brazil, and they have been important to Amazonian economies ever since (Goulding et al. 1996, Cleary 2001). While accounts from the expeditions of early explorers such as Orellana (Medina 1934) and Betendorf (Betendorf 1910) simply noted the existence and abundance of NTFRs, many others provided descriptions of the actual uses of these resources. As early as 1639, the Spaniard Padre Cristobal Acuña described specific uses of products such as wild honey, guaraná, andiroba and copaiba oils, and palm fronds (Acuña 1994). In the 18th century, Padre João Daniel wrote very detailed descriptions of NTFPs, even providing specific instructions and recipes for preparing these products (Daniel 1976). While not dedicating entire volumes to the use of NTFRs, many other explorers and scientists did in fact document the exploitation and use of NTFRs by traditional inhabitants of Amazonia well before the 20th century (Edwards 1847, Marcoy 1875, Bates 1963, Spruce 1970, Ferreira 1972).

In Latin America, interest in the development of non-timber forest species as commercial crops to help farmers was pioneered in the early 20th century by Wilson Popenoe. Popenoe's *Manual on Tropical and Subtropical Fruits* was the first book in English to cover this topic, and was an effort to encourage to the increased cultivation of the lesser-known fruits of the tropics, including fruits common in Peru such as cherimoya, avocado, and guava (Popenoe 1920, Popenoe 1921, Rosengarten 1991). Like the 19th century explorer Henry Bates, Popenoe expressed his special admiration for the many useful qualities of the peach palm (*Bactris gasipaes*), and called for more research to explore the potential of this palm (Popenoe and Jimenez 1921, Bates 1962). Thus, it should not be surprising that today, more than 70 years after Popenoe's observation, researchers have declared *B. gasipaes* to be a priority tree species for genetic improvement because of it's exceptional versatility as a component in tropical agroforestry systems, and potential as a profitable crop for farmers in Amazonia (Leakey and Simons 1998). This history of scientific interest in the peach palm reminds us of the need to study early reports from Amazonia, and that the current interest of researchers in the local use and economic potential of NTFRs is not at all new. Moreover, we learn that while Anderson (1990b) may be rightfully concerned about the need for *more* documentation of NTFR use by traditional inhabitants of Amazonia, there is in fact a long history of reports.

Since World War I, an increasing number of studies noted that forests provided an array of products other than timber of significant economic value. These were usually called "minor forest products", or "non-wood products." The importance of these forest resources was considered worthy of more attention, especially the wealth of products from tropical forests. These studies noted that while these materials were not timber, they had a long history in international trade, were in fact of major importance, and the Amazon basin was a prime area of this natural wealth (Fosberg 1948, Williams 1961).

Given this history of interest in NTFRs, it is not surprising that programs promoting the cultivation of extracted non-timber forest species as way of conserving them while enhancing rural incomes have long existed in Amazonia. For example, planting NTFRs such as rubber and cacao have been intensively promoted by public and private institutions since the end of the 19th century (Pinedo-Vasquez and Pinedo-Panduro 2002). The cultivation of non-timber forest species to increase production for export had already begun in Peru with rubber (*Hevea* spp.) just after the turn of the century, but was mostly unsuccessful (Barham and Coomes 1996). However, by the 1930s Peru was a major exporter of another NTFR, barbasco (*Lonchocarpus* spp.); a significant portion of which was cultivated, rather than extracted. Barbasco is a rotenone-containing plant native to Amazonia, which was used for insecticide. This time, Peruvian agronomists had notable success in getting large numbers of farmers to cultivate barbasco in many areas of the country (Wille et al. 1937, Villarejo 1979).

The switch by the Allied powers from Asia to Latin America for vital supplies of quinine[1] and rubber during World War II created “mini-booms” that helped to again focus attention on the importance of products from tropical trees. Peru provided over half of the cinchona bark used for quinine by the Allied forces. Considered to be the best quality found, most of this bark was still harvested in a destructive fashion from wild trees growing in the Andes region of the country (Hodge 1948). Numerous efforts to cultivate rubber and quinine in several Latin American countries began in earnest, as governments scrambled to assist the war effort, but with limited success (Popenoe 1949, Rosengarten 1991, Barham and Coomes 1996).

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[1] Quinine (*Cinchona* spp.) was a vital remedy for malaria. Java, captured by the Japanese, had supplied 95% of the world’s quinine (Hodge 1948). Today, plantations in Asia are the source of most of the world’s rubber.

While Allegretti (1990) states that scientists rarely have the influence necessary to shape government policy, and especially policy that concerns conservation and development in Amazonia, evidence presented here suggests otherwise. When we examine the literature we find that scientists helped develop programs to cultivate NFTRs, well before the recent environmental movement to conserve tropical forests. Their efforts were mix of success and failures, but Peru experienced considerable advances in the domestication and cultivation of NTFRs during this period.

Tropical Conservation and the New Interest in Non-timber Forest Resources

More recently, the extraction of NTFRs from the world's tropical forests has gained the attention of conservation practitioners, especially during the last thirty years. Attention again focused on the specific products obtained from these resources; now commonly referred to as non-timber forest products (NTFPs). Tropical forests were seen as fragile environments unable to support colonization or increasing populations of non-native humans, and the Amazon basin was no exception. The scattered and isolated distribution of useful plant species was felt to limit the potential of the forest as a food source. Researchers considered NTFPs to be important in sustaining the lives of traditional societies living in the humid tropics. These studies also recognized the exceptional productivity of the flora of floodplain environments in Amazonia (Meggers 1973, Meggers et al. 1973).

By the 1980s, researchers took renewed interest in the economic importance of NTFPs, which were in many cases the only source of livelihood for rural populations in developing countries (Panayotou and Ashton 1992). A landmark study by Peters et al. (1989a) calculated the economic value of a piece of the Amazon rainforest, and argued that the value of timber species was less than that of the NTFPs in the same area. This study was widely cited, and changed the way many researchers and policy makers viewed the Amazon rainforest because it had shown that the sustained use of a standing forest was of greater potential economic value than removing the forest for other conventional uses such as pasture.

Meanwhile, an approach to conservation that recognized rural communities' dependence on the use of natural resources had emerged. Instead of a protectionist approach, small-scale projects based on resource use were promoted (Western and Wright 1994), and a "use it or lose it philosophy" gained acceptance among conservationists (Freese 1997). Non-timber forest products were viewed as having a key role in the management of rainforest ecosystems (Anderson 1990, Prance 1994), and the concept of establishing extractive reserves to conserve Amazonian forests became popular (Allegretti 1990). A multitude of studies in the Amazon focused on how rural inhabitants utilized forest resources, including NTFRs, and their products (Hecht et al. 1988, Posey and Balée 1989, Nepstad and Schwartzman 1992, Redford and Padoch 1992). The principle of maximum sustained yield, and its utility in estimating the sustainable harvest of NTFPs continued to be seriously questioned, but socioeconomic realities dictated that people were going to extract these resources in developing countries of the tropics (Freese 1997, Neumann and Hirsch 2000).

The use of most of the Amazon's forests was now considered inevitable (Browder 1989), and the sustainable use of these forests was viewed as an alternative to deforestation. Non-timber forest products such as palm hearts, nuts, resins and fibers were an important part of this alternative (Fearnside 1989, Anderson 1990a). Researchers were also pointing out the overlooked and undervalued importance of *fruits* from the world's forests (Smith et al. 1992). In Brazil (Cavalcante 1976) and Peru (Calzada 1980 Villarejo 1979), a large number of native fruits had already been researched and promoted for their nutritional value and economic potential. These studies of forest fruits helped to promote the unique qualities and exceptional utility of NTFRs, not just for rural inhabitants, but also for the urban societies of Amazonia.

Questioning the Potential of Non-timber Forest Resources

For a time, critical discussion of the potential of these extractive reserves and economies seemed to lag behind their promotion. But as research progressed, many experts soon became skeptical of the potential for NTFRs and their products to provide either a viable economic means for people living in the rainforest or an alternative to deforestation (Gray 1990, Browder 1992a). For example, in the Peruvian Amazon, the extraction of NTFPs could quickly deplete the local resource, and was a labor-intensive activity that brought little return compared to market-oriented agriculture (Coomes 1995). Even when extraction was not for markets, but limited to subsistence use, many NTFRs in Amazonia were being rapidly depleted (Browder 1992b).

In a survey of wild-harvested fruits in the Peruvian Amazon, Vásquez and Gentry (1989) showed that the most valuable forest fruits in the markets (palm fruits) were harvested by destructive methods. Phillips (1993) followed with a study of some of these same fruit species that demonstrated how a sustainable harvest of their production was limited to very low yields in most of Peru's rainforests, and much lower than previous estimates. Although advances in research had determined the sustained-yield harvests for some species, managing these harvests was difficult, and extractors still tended to overharvest NTFRs (Pinnard 1993). Reports from elsewhere in the Amazon were not encouraging, even where NTFPs had a lasting market appeal and were important regional economies. For example, the palm heart industry had expanded to hundreds of small factories in the Amazon estuary. Despite vast populations of *Euterpe oleracea*, which regenerates quickly, factory closings were the norm as extractors moved around the region after depleting, rather than effectively managing the palms (Pollack et al. 1995, Clay 1997). With the developed world now interested in tropical conservation, we see that in less than 20 years there have been distinct changes in researchers' views concerning the exploitation of NTFRs in Amazonia. Despite a brief period of enthusiasm, grave doubts about the ecological and economic viability of these extractive NTFR economies continue to exist.

Defining Resources and Products From the Forest

There is a need to use care when describing relationships between economics and natural resources. The terms "non-timber forest products" (NTFPs) and "non-timber forest resources" (NTFRs) are often used interchangeably in the literature. While researchers have pointed out that thousands of non-timber forest products (NTFPs) are used by billions of people all over the world, we must remember that these products are environmental services, and part of the natural resource base. For that reason, it is best to look at these extracted products as forest resources, where the species is a wild, living resource (Freese 1997, Neumann and Hirsch 2000). In the case of camu camu, the fruit is an example of a product from this non-timber forest resource (the tree). Except where noted, this dissertation will consider non-timber forest resources (NTFRs) to be plant species.

Importance of Case Studies

The most recent research on NTFRs in the Amazon has shown that local and regional socio-economic factors must be examined before arriving at conclusions about the economic viability of a specific NTFP. Likewise, population dynamics, productivity and the resiliency of the species to harvest methods must also be studied in order to understand the implications for biodiversity conservation (Peters 1996, Clay 1997, Freese 1997, Neumann and Hirsch 2000). In Amazonia, studies have shown that local changes in NFTP extraction are still occurring, and how these products have increased in number and economic value in different areas (Stoian and Henkemans 2000). Studies from Peru confirm that this diversification of products can have favorable consequences (e.g., more stable incomes) for local communities in some cases (Richards 1993), but negative consequences (e.g., resource depletion) in others (Putsche 2000).

A persistent critique is that returns to effort from work with NTFPs continue to be very low. This is supported by evidence from an increasing number of case studies that show it is usually the poorest people (e.g., women, the landless) who tend to engage in these activities as a last resort for income rather than as a preferred activity (Neumann and Hirsch 2000). In Peru, however, the stakeholders themselves are often involved in management of NTFP industries (Padoch 1988b, de Jong et al. 2000, Coomes and Burt 2001). For example, the harvesting and trading of uña de gato (*Uncaria* spp.) products for medicinal uses has not threatened populations in the wild, but the lack of coordination in these activities has limited the economic benefits for the rural poor and the national economy (de Jong et al. 2000). Conversely, in certain settings, even practices considered wasteful because they were thought to require much forest for little production such as charcoal making may in fact support the both the poorest and most well-off rural families without causing notable forest destruction (Coomes and Burt 2001). A progression of studies has shown that native fruit trees from oligarchic forests of the Peruvian Amazon continue to stand out as some of the most ecologically and economically viable NTFRs for rural people (Peters et al. 1989b, Peters 1992, Peters 1996). These examples not only illustrate the need for caution when making assessments of the economic viability of NTFRs, but the need to examine individual cases. They also serve to show the considerable advances in our understanding about their exploitation in Amazonia, and the many lessons learned from case studies in Peru.

Trade From an Isolated Frontier

Smith et al. (1992) show that for centuries, a multitude of physical, economic and cultural geographic factors have strongly influenced the use, marketing and domestication of NTFRs all over the world. Sustaining these extractive industries in the Amazon has been especially challenging. Historically, access to both the resource and markets tended to be difficult or limited. The sheer isolation and distance that had to be covered in the Amazon to extract and market NTFRs limited the settings where these activities were managed and practical. The location of NTFRs relative to markets in the Amazon is a crucial factor that effects the development of their trade and management, as well as the locations where Amazonian peasants choose to settle (Padoch 1988a, Richards 1993, Smith 1999, Takasaki et al. 2000). Moran (1981) stressed that the isolation of the Amazon basin, not only from other areas of the Amazonian countries, but even within its own sparse population, makes growth and development a formidable challenge. Until systems of transport and infrastructure improve, even the highly productive, oligarchic forests in the Peruvian Amazon will remain limited in their economic value to rural inhabitants (Peters et al. 1989b, Padoch 1992, Peters1992).

Theoretical Considerations

Several scholars have complained that studies of the extractive sector of Amazonian economies have nearly always been descriptive rather than analytical, and that natural resource theory has been ignored in the analysis (Homma 1992, 1996, Barham and Coomes 1996, Wunder 2001). Taking a historical perspective, Alfredo Homma (1992) presented a model describing the economic dynamics of forest products in Amazonia. Four phases were identified in the model: (1) the expansion phase, characterized by growth in extraction due to the existence of substantial supplies in the forest; (2) the stabilization phase, when supply and demand reach an equilibrium and production is constant; (3) the decline phase, as production from the resource base declines and harvest costs increase; and (4) the domestication phase. This decline is inevitable because of the domestication of the forest product or the development of industrial substitutes for the product. Homma states that either one or both of these factors will cause the end of an extractive economy. Even domestication may fail to occur if substitutes for the product exist, or if prices are low.

This process is not only common, but can be dramatic and rapid, which is why it is often referred to as the "boom and bust" characteristic of extractive industries in Amazonia (Bunker 1984, Cleary 1998, Goulding et al. 1996). Homma (1996) went on to use the term himself, and further developed his explanation of the reasons for these booms and busts. He makes the important point that these extractive economies are not independent nor operate in a closed economy, but are linked to and affected by developments in local, regional, national and global economies.

Wunder (2001) presents a different hypothesis that is relevant to the debate over the economic viability of NTFR extraction. He argues that NTFR extraction in the tropics is an inherently temporary economic activity for impoverished, forest-dependent peasants, who once able to practice agriculture to their liking, will abandon this extraction, and if viable, cultivate these species on their farms. Rather than conserving local forests, this process leads to deforestation, rather than preventing it.

This change in activity is not inevitable, but contingent upon a flexible supply of labor, capital, and access to transport and alternative land use options. Still, it is only a matter of time before all but the most isolated, native populations are encroached upon and exposed to such conditions. Wunder concludes that it is exceedingly rare for the extraction of NTFRs or forest conservation to alleviate local poverty.

The camu camu industry in Peru has just been born, but this event is of direct relevance to theories governing patterns of exploitation of forest products. It also begs the question: From what we have learned, why would Peru launch a rural development program based on the export of camu camu fruit? To answer this question, we must first examine Peru's experiences with NTFRs.

Perspectives of Non-timber Forest Resources in Peru

Peruvians are well aware of the world-wide recognition of NTFRs from their country, and for their unique and useful products, especially as medicines. These resources are not referred to as NTFRs in Peru except by academics ("especies no-maderables" or "productos no-maderables"), but they are increasingly recognized by the masses as natural resources ("recursos naturales") and part of the national heritage. Once again, it was a priest who wrote of his travels that helped educate many Peruvians about the selva and the uses of NTFRS. *Así es la selva*[2] is still one of the most well-known books in Peru. Written by Padre Avencio Villarejo (1979), this work on the natural resources and cultural geography of the Peruvian Amazon was first published in Peru in 1943, and has been updated and reprinted several times. Villarejo described many NTFRs, their local economies, products, and international trade. While not assigning blame to any specific party, he criticized the overexploitation of NTFRs, and called for more effort to conserve and cultivate these species.

Many Peruvian scholars have concurred with Meggars (1973), and view the rainforest (selva) as a fragile environment offering little in the way of sustainable development options for their country (Rodríguez et al. 1995, Vásquez 1995). Verdera (1982) represents the so-called "traditional view" of economic development with respect to the Selva Peruana, arguing that true economic development and employment generation in the selva regions of the country are possible only through expansive agriculture[3], mining, petroleum, and timber extraction. The role of NTFRs is either ignored, or dismissed as unsustainable, and a road to poverty. This view is still politically popular in Peru, but no longer politically correct in the literature.

By the 1980s, the importance of NTFRs to Amazonian residents, economies, and ecosystems in Peru had become common topics in the national literature. This coincided with a growing awareness of environmental issues in Amazonia (Bebbington and Thiele 1993), and the growth in the number of research projects aimed at these species (Dourojeanni 1990, Nepstad and Schwartzman 1992). These efforts were pioneered by researchers and conservation practitioners working in the selva regions of Peru, but their importance was soon recognized nationwide. Non-timber forest resources were now increasingly noticed for their importance to *urban* people of Amazonia. Citing their role in forest ecosystems, many Peruvian researchers promoted the in-situ management and conservation of these natural resources (Villarejo 1979, Vásquez and Gentry 1989, Alvarez 1989, Kalliola et al. 1993, Murrieta 1993).

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[2] Translated: This is the jungle.

[3] Ironically, the term "traditional agriculture" for government planners in Peru usually refers to expansive, non-indigenous cropping systems and livestock, rather than agroforestry systems and native crops that have been traditionally cultivated by people of the region.

Despite the promotion of NTFPs as a way to conserve forests and raise rural incomes (Pacheco et al. 1998), many environmentalists in Peru also dismissed their potential to conserve forests because of destructive harvest methods used by extractors, and the fact that protected areas were a major source of these resources. They argued that since this extraction was usually illegal to begin with, development based on their use could not be considered. Furthermore, it was rural inhabitants who were to blame for most of this illegal extraction (Bayley et al. 1992, Rodriguez et al. 1995). Fierce debates among conservation and development circles in Peru have emanated from this protectionist position, and there have even been calls to boycott the consumption of foods from the wild.

Saqueo Amazónico

This is not the first time that debates have erupted in Peru over whom is to blame for the grinding poverty and misuse of non-timber forest resources in the selva. From a historical perspective, writers in Peru have tended to view rural residents as the victims of extractive economies, especially boom and bust economies in NTFPs that were dependent on the often brutal exploitation of their labor. At the macro-level, the blame for this exploitation was usually directed at the expansion of capitalism and colonialism during the rubber boom, which prevented economic development and left the region impoverished[4]. Some of the most well-known literature in Peru describes this problem as the never-ending "saqueo", or thieving of the Amazon; which makes efforts at natural resource conservation and economic development impossible (Chirif 1979, 1983, Pennano 1988). Indeed, the use of the word saqueo when describing forest extraction and even everyday business deals is still common today in the Peruvian Amazon.

Despite the popularity of this perspective, many Peruvian authors have placed the blame for the atrocities during the rubber boom squarely upon the actions of Peruvian rubber barons and patrones (Rumrrill 1982, Barclay et al. 1991, Valcárcel 1991, Soregui 2001). Even the anti-imperialist Chirif (1979) has acknowledged that the extraction of NTFRs has for the most part benefited not foreigners, but Peruvian entrepreneurs from Lima; who there, along with the central government, have carried out their own exploitative colonization process in the selva regions of Peru. In fact, all of the aforementioned publications have expressed frustration with this outward flow of wealth to Lima, and the lack of local development the Peruvian Amazon, including the more recent misuse of revenues from petroleum extracted in Loreto. In this sense, the authors view the selva regions themselves, not just their people, as victims of exploitation and underdevelopment. Even Peruvian president Fernando Belaunde, proponent of road colonization[5] and expansive agriculture for the "conquest" of the selva during the 1960s, admitted that his government had devised these programs with an eye toward ending what he called the "selfish abuse" of these lands (Belaunde 1965, p. 218). Rather than debating the merits of extraction, the common attribute of these writings is their concern over how wealth generated by extraction has been distributed, and exactly how it could be used to benefit the Peruvian Amazon. Without changes in such exploitative systems, the conservation of natural resources is viewed as impossible (Chirif 1983).

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[4] Collier's "The River that God Forgot" (1968) was translated to Spanish in Peru in 1981 (*Jaque al Barón: La historia del caucho en la Amazonia*), and edited with additional comments about how imperialism was to blame for atrocities committed by rubber extractors, and that British concerns over the violence and brutality in the Putumayo were false.

Ribereño Perspectives

An important element is missing from this background – the views of the ribereños. My initial research experiences gave me the impression that many of them were aware of these debates about NTFR extraction and rural poverty within the urban classes; because they would point out that it was consumer demand from the cities that caused them to practice this extraction. Numerous ribereños described their debt-peonage relationships with patrones, but most of their complaints were in fact directed at the history of exploitation by intermediaries who purchased their NTFPs at markets, and the boat owners they paid to sell these products. They tended to be suspicious of programs that encouraged them to cultivate these non-timber forest species or market NTFPs because they felt their share of the income in this trade was inherently miniscule due to the ever-present intermediaries involved in the marketing process.

These ribereño views were often heard on local radio and in NGO workshops, but almost never published in Peru. For example, it is rare for environmental NGOs to criticize habits of consumption by urban people. Again, these problems may be partly due to the pervasive perspective of conservation promoted by environmental NGOs; which tend to focus on human behavior in the forests, rather than urban links to natural resource exploitation. Analogous to the arguments in Peruvian literature over the transfer of regional wealth to the national capital, many ribereños told me that if *they* received a fairer share of the wealth generated from these natural resources, conservation and development would be possible in their communities.

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[5] These were the Carretera Marginal (Perimeter Road) projects that connected towns in the high selva of Peru.

Scientific Research and Changes in the Selva

Rumrrill (1982) and Dourojeanni (1990) readily acknowledge the economic potential of Peru's rainforests, but stress that the selva environments of Peru are fragile and in crisis due to their commercial use ("uso commercial") , requiring immediate action to address what they feel is an emergency. While acknowledging the history of human exploitation and abuse involved with the extraction of NTFRs from Peru, they are quick to point out the role of regional authorities and local people in this process, and the persistent problem of a local, extractionist mentality. These authors are especially critical of urban cultures in Iquitos and Pucallpa, which they view as consumerist, uneducated, and unconcerned with the destruction of the natural resource base and traditional culture (ibid.). During my research, some local scholars complained about the views of these authors as condescending, "coming from Lima", and even racist. Coupled with these opinions is the long-standing frustration of the people of the Peruvian Amazon over what they view as the domination of their region by people from Lima, the capital city.

In his influential book *Amazonia: ¿Que Hacer?*[6], the Peruvian agronomist Marc Dourojeanni (1990) makes clear that NTFRs are undervalued resources, and that the human exploitation and lack of economic development associated with their economies is a result of the pursuit of short term wealth, rather than inherent limitations with the resources themselves. In fact, he considers himself an optimist, and makes a convincing argument that NTFRs should be a part of long term, forward-looking management strategies. Dourojeanni also felt that the use of most of Peru's selva was inevitable, and promoted alternatives forms of development in the region, including the sustainable use and cultivation of NTFRs. These alternatives were based on the findings of many studies coming from Amazonia, including the new research institutes in Peru. The author lauded the recent creation of the Instituto de Investigaciones de la Amazonia Peruana (IIAP) and their research stations in Peru, while criticizing the personnel of traditional government ministries such as the Ministry of Agriculture as unqualified and incompetent. The book gave a boost to proponents of the sustainable use of forest resources, including NTFRs, while angering many traditional development practitioners. To Dourojeanni, it was not economic systems that needed reform, but the self-serving interests and money-wasting practices of individuals who managed development projects. He argued that if competent scientists were involved, forest conservation and development would be possible in the selva regions of Peru (ibid.).

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[6] Translation: "Amazonia: What to do?"

Not surprisingly, scientists and extensionists working in the selva Peruana have responded by arguing that Dourojeanni lacked real solutions for sustainable development, and was simply heaping elitist criticisms upon them. Moreover, the Peruvian government had indeed responded to environmental concerns and implemented laws that limit extraction of NTFRs, but efforts at enforcement were ineffective (Padoch 1988b).

Bringing Attention to Native Fruits in Peru

A modern pioneer in promoting the national recognition and appreciation for NTFRs in Peru was agronomist José Calzada. Calzada's *143 Frutales Nativos* (1980) was widely distributed in Peru, and brought these species to the attention of students, researchers, and policy makers throughout the country. Calzada did most of his field work in the selva near the city of Pucallpa, and felt that these native species could easily provide the city with its need for fruits, rather than transporting expensive apples, grapes, and other fruits great distances from the coastal areas into the selva baja.[7] Moreover, Calzada stressed that the lesser-known native fruits from Amazonia should be cultivated wherever possible, and could easily provide the same or higher level of nutrients to Peruvians as the most popular, domesticated fruits eaten in Lima. Calzada gave high regard to camu camu, and the fact that it was Peruvian researchers who had discovered the extremely high concentration of Vitamin C in the fruit (ibid.). This book helped lay the groundwork for rural extension programs to focus their attention on the in-situ management and ex-situ cultivation of non-timber forest species, and was used as a basis for many studies to come.

A Boom in NTFR Research in Peru

Encouraged by new scientific interest and international support, government institutions in the Peruvian Amazon such as IIAP, the Instituto Nacional de Investigación Agricola (INIA), the Ministry of Agriculture, and universities made the research of NTFRs a priority. No doubt inspired by Calzada's work, the movement now focused on studies of these and species traditionally exploited by rural inhabitants. The aim was still to conserve these species in the wild, but more interest focused on their cultivation.

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[7] Rita Riva, PNCC-Pucallpa, personal communication, 2002.

Agroforestry systems that incorporated non-timber forest species were now considered essential to promote and sustain this cultivation (Dourojeanni 1990, Paitán 1997, Salo and Torres 1998).

By the 1980s, many different manuals explaining how to cultivate or manage NTFRs were distributed throughout the selva Peruana. Non-timber forest species such as "aguaje" (*Mauritia flexuosa*), "uña de gato" (*Uncaria* spp.), "sangre de grado" (*Croton lechleri*), palm heart (*Euterpe precatoria, Bactris gasipaes*) were just some of the species that received specific attention in Peru. A primary reason for the interest in the domestication of these NTFRs was the interest in exporting their products to Europe, North America, and Asia (Arévalo 1996, Paitán 1997, Salo and Torres1998, Lock Sing 2001, López 2001). An often overlooked attribute of these products was their expanding domestic market, which insured at least some commercial success with their cultivation. Meanwhile, the International Center for Research in Agroforestry (ICRAF) selected native tree species that it considered to have the most potential for genetic improvement and agroforestry applications in the Peruvian Amazon.[8] ICRAF felt that if farmers were to widely adopt native tree species, they must have access to superior genetic stock in order to maximize benefits obtained from their cultivation (Leakey and Simons 1998).

It is unclear whether these new efforts at NTFR domestication in Peru were concerned with the end of extraction as Homma (1996) had proposed, or were in fact part of a deliberate strategy to reduce harvest pressure on wild species as Pinedo-Vasquez and Pinedo-Panduro (2002) claim. What they do tell us is that Peru continued to gain considerable experience in cultivating NTFRs by focusing efforts on the more promising species. At the same time, the creation of hundreds of new NGOs in Peru helped fuel the promotion of NTFRs in conservation or rural development projects, no matter what the actual purpose of the organization might be (Bebbington and Thiele 1993, Meyer 1999).

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[8] These were *Inga edulis, Bactris gasipaes, Cedrelinga* sp., and *Guazuma crinita*.

Camu Camu in the Peruvian Amazon

Outside of a few institutions, camu camu was still poorly understood, believed to be a strange aquatic plant, which, despite its bounty of nutritious fruits, was not well suited for cultivation (Moraes et al. 1994). For example, even some of the more recent publications describe *M. dubia* as a bush reaching a height of just 3 meters (Hoyos 1994, Villachica et al. 1998), when the trees are noticeably taller, growing to more than twice this height. Such conclusions may have come from observations that were limited camu camu found in high water, or newly cultivated trees. There was also uncertainty over where stands of camu camu were located; especially the larger stands (Peters and Hammond 1990, Villachica et al. 1998, Vásquez 2000). Camu camu stands are well known by locals as habitat for valuable fish species that feed on the fruits, but extensive studies on Amazonian fish that feed on fruit material (Goulding 1986, Araujo-Lima 1997) fail to list *M. dubia* as part of their diets. During this dissertation research I was surprised by the number of Peruvian researchers and students that asked me to describe the size and appearance of the plant; who were intrigued after seeing the fruits for sale in local markets. At the same time, this species was not well-known to most rural inhabitants of the Peruvian Amazon. *Myrciaria dubia* is widely dispersed in this vast region, but in small patches totaling perhaps no more than 3000 hectares (IIAP 2001). Finally, *M. dubia* does not appear to have a history of cultivation in the traditional agroforestry systems of the ribereños. These factors help explain the limited familiarity with the species, and the lack of early attention given to camu camu by rural development programs. It also raises an important question: How had *M. dubia* been used in the past?

Ethnobotany of Camu Camu in Peru

In northeastern Peru, camu camu fruit was traditionally used as fish bait, and the tree was a source of high quality firewood. While fishing, people would cover their catch with the smaller, leafier camu camu branches to protect it from the sun. The hard, strong wood is also used in light construction. The fruits would ripen on the trees until they appeared almost black in the bright, reflected sunlight on the water. Rather than collecting the fruits, the older ribereños told me they would whack the fruit laden branches with their paddles as they canoed by the trees, to relieve their boredom, and how the fruits would rain into the water, as food for the large gamitana fish (*Colossoma macropomum*) that were common in stands of camu camu.

Since the early 1970s, the fruit was sent to Iquitos markets where it slowly became popular over the years to prepare beverages, popsicles and sweets. Before this, Loretanos rarely, if ever, consumed the very tart fruit. Some ribereños told me that they would occasionally suck the fruits when very thirsty (at times the black waters where camu camu grows are considered undrinkable). After learning of its uses in Iquitos, they began to prepare beverages from the fruit. I was told that the medicinal uses of the plant[9] they had developed were in fact recent innovations. These findings make it more understandable why *M. dubia* was not a component in the traditional agroforestry systems of the region, and suggests that camu camu was a forest resource of limited value to inhabitants of specific localities where the species was found. During our conversations, some older ribereños referred to camu camu as a "bad weed", because they did not enjoy the fruit and viewed the dense stands of the trees as places where they too often tangled their nets or lodged their canoes when fishing.

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[9] Many people cook the juice with sugar to treat anemia. Others make a concoction with the cortex steeped in aguardiente to prevent rheumatism. With the publicity and new demand for camu camu, a large number of homemade products have recently been created.

The meaning of the word "camu camu" remains a mystery for the people I interviewed, even those who had lived long lives associated with this native fruit, such as fishermen. Still more perplexing was the fact that most of them who lived near wild stands of camu camu told me that they had not even known of a name for the fruit until it began to be sent to market in the early 1970s. One biologist told me that the fruit acquired this name because "camu" mimics the sound of the fruit as it falls into the water.[10] I tested this phenomenon in the field, and with some stretch of the imagination the explanation seems plausible. However, the locals were unimpressed with the tests, and did not agree.

In his extensive archival research pertaining to cultivated plants, Patiño (1963) describes how several varieties of guavas (*Psidium guajava*) found in the lower Andes are referred to as "sahuinto", which is a Quechua word (pp. 372, 377). Some of the locals I interviewed used the word "shahuinto" as a name for the larger tree species of *Myrciaria* (Chapter 1). The practice of reduplication is noticeable in the Quechua/Quichua language [11], but my informants who spoke the language said they did not know what "camu camu" meant.

Chaumeil (1979) includes the word "kamu kamu" in list of Yagua words from a study conducted downriver from Iquitos. It is not clear, however, if this inclusion means that the word is of Yagua origin, because other names of common flora and fauna appear on the list where the letter K simply replaces the letter C for the vernacular name. Yagua speakers told me they did not know what the word meant. This uncertainty is understandable, given the fragmentation and disappearance of tribal societies on the floodplains of Amazonia . Cabral (1995) warns that by now there are severe limitations on our ability to trace the origin of floodplain language in Peru, and that borrowing was and still is common for native languages of the region.

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[10] Antonio Lopez, personal communication (2002).

[11] Dr. Diana Boxer, Department of Linguistics, University of Florida, personal communication, 2003.

Obviously, more research is needed to answer the many questions concerning the traditional use of camu camu in Amazonia. Lacking a known tradition of cultivation, extensive use, or trade, many researchers have had to scramble to become familiar with camu camu since the commencement of the industry. This situation reminds us of the vital contribution that local knowledge makes to our understanding of these non-timber forest species. The lesson from this is that when it comes to our comprehension of the use and domestication of NTFRs, we may still be highly dependent on local knowledge (Chambers et al. 1989, Rocheleau et al. 1989).

Non-timber Forest Product Commerce and Damage to Human Cultures in the Peruvian Amazon

The history of trade in NTFPs in the northeast Peruvian Amazon is long and varied, involving a diverse number of products. Regrettably, local populations have gained little economically from the many short-lived economic booms resulting from this trade, and the environment has suffered from the destructive harvest practices that were encouraged by these extractive pursuits (Padoch 1992). Supporting this claim are the accounts of the local people, who have little or nothing to show for their work. Older ribereños and natives told me of their work extracting caucho[12] (*Castilla* spp.), leche caspi (*Couma macrocarpa*), balata (*Manilkara* sp.), and rosewood oil (*Aniba roseadora*), all of which resulted in the destruction of these species.

Along with this ecological damage, we must not forget that the commerce in NTFPs resulted in the cultural degradation of rural societies in northeastern Peru, including the disruption and displacement of ribereño communities today (Barclay et al. 1991, Padoch 1992, Coomes 1995). Before this, the trade had contributed to the destruction of Amerindian societies in Peru (Collier 1968, Stanfield 1998). This included the fragmentation of Amerindian societies along the Amazon floodplain (Cabral 1995), who were also the ancestors of most ribereños (Chibnik 1991, 1994). It may be that the very knowledge we seek concerning the ethnobotany of camu camu; now a celebrated a NTFP in Peru, has been made more difficult to find due to the consequences of trade in these products on rural societies in the Peruvian Amazon. Moreover, even with all the lessons learned from these painful experiences, recent studies demonstrate that this durable pattern of destructive extraction for NTFRs still persists in the Peruvian Amazon (Padoch 1988b, Vásquez and Gentry 1989, Alvarez 1989, Padoch 1992, Mejia and Alvarez 1998).

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[12] In Peru, most of the rubber extracted during and after the boom was not of the genus *Hevea*, but from species of *Castilla* called "caucho"in Peru (Villarejo 1979, Pennano 1988, Stanfield 1998). This rubber was not tapped from the tree over a period of years as *Heava* was, but was instead collected by quickly bleeding it until empty, which destroyed the trees. A cauchero had an image as destroyer, in contrast to the more benign image of a seringueiro tapping Hevea.

Non-timber Forest Resources: Camu Camu in Peru

Vitamin C and the International Interest in Camu Camu Fruit

From what we have learned so far, it was not by studying the traditional use of camu camu that researchers took an interest in camu camu. Rather, its unique chemical properties are what created a special interest in this NTFR. Many neotropical fruits, including cashew, guava, (*Psidium guajava*), and acerola (*Malpighia punicifolia*)[13] are high in Vitamin C content (Table 2-1). Camu camu captured the attention of Peruvian researchers during the 1950s because they found the fruit to be the extraordinarily high Vitamin C. With 2700 - 2800mg of ascorbic acid in100 grams of fruit pulp, camu camu contained about 30 times the Vitamin C by weight as an orange (Ferreya 1959, Calzada 1980). While Table 2-1 shows that eating many fruits found in the study area can provide the minimum RDA of Vitamin C, consuming only a few grams of camu camu will do this.

Government research institutions and some private firms in Peru soon took an interest in *M. dubia* as a source of ascorbic acid. It is not clear exactly when other countries took an interest in *M. dubia,* but camu camu products were sent in small quantities to Europe and the United States during the 1960s (Whitman 1974). However, it was Japanese firms that had displayed an interest in native fruits from the Peruvian Amazon since the 1980s, if not longer (Padoch 1988b).

With help from the Japanese Embassy in Lima and President Alberto Fujimori,[14] Peruvian officials sent samples of camu camu to Japanese firms during 1992 and promoted prospects for trade in the Vitamin-C rich fruit. At least one major beverage large quantities the fruit. Formal plans to export at least 10,000 tons of camu camu fruit pulp annually to Japan were soon initiated (Riva and Gonzales 1997, Villachica et al. 1998, Correa 2000). Given the persistent pattern of destructive extraction for NTFRs in northeastern Peru and the lack of economic gain from their international trade, even when cultivated (Valcárcel 1991, Padoch 1992), such plans seem ill-advised. What may have led to Peru to launch a development program based on the export of yet another NTFR from Amazonia? To answer this question, we must examine both the nature of camu camu extraction and the development program itself.

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[13] Acerola is not common in the study area. The fruit contains 1800-1900mg of ascorbic acid per 100 grams of fruit - source (Alvez et al. 1999)

[14] Fujimori was from Japan, and advocated increased trade between Peru and his native country.

Exploiting and Cultivating Camu Camu in Peru

A review of the literature and government documents concerning camu camu reveals several reasons why Peruvian planners may have promoted an export industry based on the fruit. First, camu camu produces high yields of fruit in the wild. *M. dubia* forms dense stands characteristic of the region's oligarchic forests, which are usually dominated by a single species and composed of few others.[15] These oligarchic forests are exceptionally productive, allowing them to be sustainably exploited at harvest levels far above most other useful species in the Amazon (Peters et al.1989b). In a study done of wild camu camu in Supay Cocha with the Instituto de Investigaciones de la Amazonia Peruana (IIAP), Peters and Hammond (1990) estimated fruit production at 9000 to 12,000 kg per hectare. This study was widely cited by Peruvian planners and researchers, who felt that the exceptional productivity of wild camu camu could justify its increased exploitation for export to Japan.

Second, this non-timber forest species could be exploited in a sustainable way. Camu camu fruit is harvested by simply picking the fruits by hand, or using a pole to reach them. The resource is not destroyed, but harvested in a “non-predatory” manner (Homma 1992). Studies concluded that the small trees could be sustainably exploited in the wild because persistent fruit collection was felt to have little effect on the structure and function of the species. This factor, along with the high yields of natural populations, makes the economics of these harvests especially favorable (Vásquez and Gentry 1989, Peters and Hammond 1990, Villachica 1996, Paitán 1997). For example, Peters and Hammond (1990) estimated that camu camu harvests in Peru had the potential to earn from $5700 to $7600 per hectare. These figures seem far-fetched, but such reports had spurred renewed interest in camu camu export and cultivation. Thus, planners did not seem hesitant to exploit camu camu in the wild because *M. dubia* was a species that was exceptionally productive and resilient to intense exploitation.

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[15] Peters (1990) has also called these monotypic forests because of the dominance of a single species.

Japan could use far more camu camu than Peru could immediately supply them with, although the initial plan was to import just 10,000 metric tons of fruit per year. This fruit was to be extracted from the wild, but it was soon discovered that the known wild sources of camu camu could not supply even this amount (Riva and Gonzales 1997, Villachica et al. 1998, Riva 2001). Luckily, Peruvian researchers already had considerable experience with camu camu cultivation that would help them to jump-start cultivation programs with small farmers and quickly move to supplement wild sources of the fruit. Since the 1970s, research institutes near Iquitos had been quietly advancing their knowledge about camu camu. Encouraged by results from experiments with the fruit decades earlier, researchers from INIA, IIAP, and other institutions experimented with the extraction and cultivation of *Myrciaria dubia* (CAMPFOR 1995, Correa 2000, Pinedo-Vasquez and Pinedo-Panduro 2002). Supporting these claims, I visited 23 year old plantings at an abandoned research station of the Peruvian Primate Project (PPP) during this dissertation research. Near Pucallpa, where wild *M. dubia* does not exist, government researchers and private industry had also made important gains in cultivating the fruit on an experimental basis (Riva and Gonzales 1997). Like barbasco planting programs conducted over half a century earlier, we see that scientists at Peru's research institutions were well-acquainted with the cultivation of the NTFR they were to promote among small farmers.

From an economic standpoint, cultivating camu camu was seen as an ideal way to improve rural incomes. In floodplain environments, development options, especially agroforestry, are limited due to seasonal flooding (Hiraoka 1986, Bayley, et al. 1992, Durand and McCaffrey 1999). This was a major frustration of developmentalists in Peru; the inherently risky, seasonal nature of agriculture on the floodplain limited farming options and production in the most fertile lands of the region (Chibnik 1994, Nebel 2001). With camu camu, a flood-resistant, highly productive tree crop had now become a key species for agroforestry projects on the floodplains of the Peruvian Amazon. Rather than worry, there was a sense of certainty about marketing the fruit, as potential demand from Japan alone for camu camu was estimated to be as much as 230,000 metric tons per year (Villachica et al. 1998, Picón and Acosta 2000, Riva 2001).

Finally, the recent boom in conservation and development projects (Bebbington and Thiele 1993, Meyer 1999) had helped governmental institutions and NGOs throughout the Peruvian Amazon acquire considerable experience working in rural communities. Thus, the timing of the deal with Japan seemed ideal because institutions in Peru were well-positioned to help the industry make a take-off. Despite their differences, the government, private entities, research institutes, and NGO's managed to cooperate and came together to promote the planting of camu camu with rural families (see Paitán 1997, Salo and Torres1998, Vásquez 2000, IIAP 2001, Riva 2001).

Camu camu planting started as reforestation projects funded by the Peruvian government and implemented by state and private institutions in 1995. Amid much publicity, Peru soon launched the Programa Nacional de Camu Camu (PNCC) in 1996. The PNCC aimed to initially plant 10,000 hectares of the trees with 10,000 rural families living along the floodplains. This would foster development of the new export industry, while raising household incomes of small farmers. Meanwhile, Peru created incentives for both private industry and non-profit extension organizations to collaborate with the PNCC (Riva and Gonzales 1997, IIAP 2001, Correa 2000, Riva 2001, Pinedo-Vasquez and Pinedo-Panduro 2002). Much propaganda has surrounded these efforts, with rosy predictions of future earnings and prosperous farmers.

To be fair, this excitement in Peru was understandable. There was a pressing need to improve the standard of living in the Peruvian Amazon, and to consider ways to increase the economic output from the floodplain other than fish and timber (Nebel 2001). The poverty rate for Loreto in 1993 stood at 52.8% - the highest rate of any province in Peru; while in Ucayali province it was 43.9% (O'Hare and Barret 1999). To offset such poverty in Amazonia, the Fujimori government launched FONCODES[16] , a widespread program that paid Peruvians to build infrastructure during the 1990s (Ancajima 2000). However, there had been no major agricultural initiatives in Amazonia or support for farmers since the agricultural credit programs of the late 1980s (Coomes 1996).

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[16] FONCODES is the Fondo Nacional de Compensación y Desarrollo Social).

or support for farmers since the agricultural credit programs of the late 1980s (Coomes 1996).

Peruvians researching the national commerce in NTFPs have repeatedly emphasized the destructive nature of these activities (e.g., Villarejo 1979, Vásquez and Gentry 1989, Mejia and Alvarez 1998). With camu camu, a unique product had attracted the interest of health-conscious consumers both at home and abroad; an exceptionally nutritious fruit that could be exploited without destroying the rainforest. This had attracted the attention of the sustainable development and conservation community. The regional government had been trying to raise the incomes of rural families, with little success in recent years (Coomes 1996). At the same, the national government had been trying to expand Peru's fruit export sector, and camu camu will contribute to this goal (Breuer 1999). Thus, a NTFP, camu camu, appears to meet the ecological criteria for sustainable exploitation; while it satisfies local, regional, and national development objectives. To many observers, the Peruvian Amazon had found an ideal eco-friendly development project in the camu camu export business.

Conclusion

This chapter began an examination of the literature concerning non-timber forest resources exploited in the tropics, Amazonia, and most notably the Peruvian Amazon. It was seen that research on NTFRs was at first motivated primarily by the interest in understanding their role in sustaining the lives of traditional societies, and their commercial potential. This interest is not new, as prominent explorers played a key role in the promotion of these resources to the outside world for centuries. Since the 1970s, it is clear that there has been an evolution of perceptions in the conservation literature about way in the 1980s to an enthusiastic endorsement of economic development and forest conservation based on NTFRs. For a time, it seemed that critical analysis lagged behind promotion of NTFRs in the 1980s. Subsequent research produced an important debate in the literature about this premise. Enthusiasm waned as case studies began to reveal fundamental problems with increased use of NTFRs. The most recent publications tend to cast an increasingly critical eye towards NTFRs as a way to alleviate poverty and conserve tropical forests, while being careful to acknowledge specific cases of success.

Along with important studies of NTFRs in Peru, this chapter has shown there are well-developed debates in the national literature about their economic and ecological viability. More specifically, there is debate in Peru over who is to blame for the persistent poverty associated with extraction in Amazonia. This is partly because of Peru's historical experiences with NTFR exploitation and partly because of the continuing concern with not just the conservation of these species, but with their value to the nation; and contribution to the national, regional, and local economies. In this sense, NTFR exploitation is clearly a domestic issue, not just an academic treatment of the challenges of tropical conservation and development. The depletion and destruction of plant resources for non-timber forest products is still a serious issue in northeastern Peru, where consumption of these products is very popular, especially fruits.

Contrary to the arguments of Allegreti (1990) and Anderson (1990b), this chapter has shown that scientists did indeed play a role in government forest policy in Latin America, and have been instrumental in promotion of sustainable NTFR use and cultivation in the Peruvian Amazon for over a century. With the early planning of the camu camu export business, Peruvian researchers had already amassed more than 20 years experience in the study and cultivation of *Myrciaria dubia*.

As presented in the literature, the case of camu camu exhibits a departure in many ways from the standard pattern of NTFR exploitation and cultivation in Amazonia because the ecology and economics of camu camu extraction is felt to be quite favorable. Harvested in a non-destructive manner, research has shown that this species provides exceptionally high yields of valuable, increasingly marketable fruits, while being resilient to persistent harvest pressure. These favorable characteristics differ from those typical of NTFRs in the tropics as summarized by Neumann and Hirsch (2000). At the same time, we learn the importance of evaluating the ecological and economic viability of NFTRs on a case-by-case basis.

While the case of camu camu in Peru illustrates a species that has been the subject of much study, it also reveals a situation of concern. The lack of ethnobotanical knowledge about *M. dubia* shows how we are still dependent on local knowledge to advance our research. Analysis from this chapter suggests that the very knowledge we seek may have become less accessible due to trade in NTFRs. Questions remain where traditional knowledge could provide us with valuable clues concerning the taxonomy, location, and abundance of wild *M. dubia*.

With camu camu in Peru, available literature suggests planners seem determined to avoid falling into the boom and bust cycle that has plagued NTFR economies in Amazonia. Camu camu is entering the cultivation phase, in accordance with Homma's model. This change is planned, and desirable. Again, with this NTFR, we see ample cooperation between scientists and government policy makers. Camu camu is proudly portrayed in Peruvian publications as a national resource treasure that is not to be squandered. To reinforce this position, the export of whole camu camu fruits or seeds from the country was made illegal in 1996 (IIAP 2001).

In this chapter, we have seen how the case of camu camu is unique in many positive ways from that of other NTFRs in the Peruvian Amazon. The tree has favorable characteristics that appear to make it an exceptionally promising candidate for domestication, without many of the limitations and constraints that other NTFRs present to planners. Peru had spent considerable time studying NTFRs, and understands this species well. Thus, the timing of the deal with Japan seemed ideal because institutions in Peru were well positioned to help this industry make a take-off.

Can camu camu cultivation replace extraction from the wild and support this new export industry? This local history suggests that planting camu camu could be an excellent way for floodplain farmers to prepare for the future. This raises the question of how rural inhabitants would cultivate camu camu, and the nature of *their* perspective on the new industry. Would rural communities be interested in cultivating this new floodplain crop? My initial research experiences gave me the impression that they were almost always on the receiving end of these policies. The next chapter will present findings from field research that examines these important questions.

Scientific name	Vernacular name	Vit C mg per 100gr
Myrciaria dubia	Camu camu	2780
Anacardium occidentale	Casho, marañon	180
Citrus sinensis	Naranja	92
Solanum sessiliflorum	Cocona	80-200
Ananas comosus	Piña	61
Pouteria caimito	Caimito	49
Carica papaya	Papaya	46
Rollinina mucosa	Annona	43.4
Psidium guajava	Guayaba	37-300
Copoazu	Theobroma grandiflorum	33
Hymenaea courbaril	Azucar huayo	33
Campomanesia lineatifolia	Palillo	33
Passiflora quadrangularis	Tumbo	33
Spondias mombin	Uvos	28
Mauritia flexuosa	Aguaje	26
Annona muricata	Guanabana	26
Theobroma bicolor	Macambo	22.8
Bactris gasipaes	Pijuayo	22.6
Passiflora edulis	Maracuya	20
Passiflora nitida	Granadilla	15.8
Matisia cordata	Zapote	9.9
Eugenia stipitata	Arazá, guayaba brasilera	7.68
Musa sp.	Plátano, guineo	4-9
Genipa americana	Huito	1.1
Pourouma cecropiifolia	Uvilla	0.6

Table 2-1. Vitamin C content of fruits commonly consumed in the study area. Source: Calzada (1980), Paitán (1997).

CHAPTER 3

COMMUNITY PARTICIPATION IN THE PROGRAMA NACIONAL DE CAMU CAMU

Introduction

Successful adoption of new agricultural practices depends on a broad number of factors, including the socioeconomic environment where programs take place. Despite continued advances in research and development programs, many factors still constrain the planting of trees by small producers in the tropics (Long and Nair 1999, Franzel and Scherr 2002, Simmons et al. 2002). Planners' attempts to implement agroforestry strategies have been characterized by a lack of success (Nair 1993). Even when extension projects are prioritized, the results of their impact on land use have been mixed Scherr (1992). Above all, the expectations of the people in the project area have to be satisfied by the project in order to insure credibility and cooperation over the whole of the project (Durand and McCaffrey 1999). The Programa Nacional de Camu Camu (PNCC) wanted large numbers of communities to plant camu camu (Correa 2000), but they hardly responded to the programs and incentives (Pinedo-Vasquez and Pinedo-Panduro 2002).

Numerous studies have demonstrated the diversity and variations in subsistence activities and economy between communities of the Peruvian Amazon (Denevan and Padoch 1988, Padoch and de Jong 1989, Chibnik 1994, Coomes 1995, de Jong 1996, Coomes and Burt 1997). Among such communities this variation affects choices about participation in poverty reduction programs (Hentschel and Waters 2002). With communities in the Peruvian Amazon, failure to understand this diversity hinders the success of development programs in the region (Tagasaki et al. 2001).

To promote the adoption of agroforestry systems, planning agencies must influence the geographic location of these projects in accordance with development objectives, including marketing (Vosti et al. 1998). Coomes (1995) and Takasaki et al. (2000) show that in Peru, the location of ribereño villages in relation to markets and natural resources can strongly influence the nature of their economic activities. Given these findings, it is logical to hypothesize that certain villages would be more likely to adopt camu camu planting on the floodplain than others.

Top-down management processes in development organizations often pay only lip-service to calls for community involvement, while failing to actively engage the local people (Brown 2002). Too often, rural development projects such as tree planting fail because top-down planning approaches give little serious attention to the social and cultural realities in local communities (Loker 2000). In Peru, community involvement with the many camu camu planting projects of the PNCC was limited (Pinedo-Vasquez and Pinedo-Panduro 2002).

The reasons why farmers adopt agroforestry and tree planting practices must be evaluated on the basis of social and economic conditions within particular locales and at particular historical periods (Belsky 1993, Walters et al. 1999). Floodplain communities in the Peruvian Amazon have a history of resisting external pressures and chose to adapt to circumstances in their own, unique ways (Pinedo et al. 2002). At the same time, success of extension activities can depend largely on extension agents and their relations with farmers (see Rivera and Zijp 2002). Regardless of the overall success of development programs, top-down exogenous forces and local reality inevitably combine to leave a unique "imprint" on the landscape that is unpredictable in the planning stage (Brown 1991).

In this chapter I examine the response of rural communities to the PNCC, and the reasons why communities decided to participate or *not* participate in the camu camu planting program. Data obtained from communities who had participated in the PNCC is analyzed and compared to non-participant communities. Questions of location and market access, village livelihoods and specialties, agricultural traditions, and experience with development projects are discussed in order to determine if these factors indicate what types of communities were planting camu camu. Community needs, their recent histories, and adaptations to change provide a framework for analysis. Attention is given to the role of state and non-governmental organizations in this process.

Methods

Two main methods were used to learn why communities had decided to participate or not participate in the PNCC, and what was driving the process of camu camu adoption or non-adoption. One was the use of formal interviews; the other was informal interviews and conversations. A semi-structured questionnaire was used to question groups of villagers about socioeconomic characteristics and environmental attributes of their community (Appendix A). The questionnaire was also used to elicit the reasons why these communities had decided to participate or not participate in camu camu planting. The research questions were developed in the field by first conversing with groups of people not participating in the study. The questionnaire in Appendix A contains a list of questions that are ordered here, but they were asked in sequences that were most comfortable and fluid during the interviews.

The questions were asked to groups of six to ten adults in each community by usually meeting in a school, community meeting house, private home, or place where we could talk openly and honestly. We then took a walk around the community and into nearby fields. This served to stimulate conversation about village characteristics and agricultural practices, which helped answer the questions. At times it also offered a more private setting where villagers could speak more openly about their communities and neighbors.

A key method employed in this study was to ask those people who seemed uninvolved or uninterested in my visit or the issue of camu camu. The goal was to learn what they had to say about the people I had interviewed, the nature of the community, camu camu, and other facets of their reality. Whenever possible, local authorities were also interviewed, taking into consideration that their responses were often motivated by personal gain (see Bernard 1994). These additional methods consistently yielded good information.

Before visiting the rural areas, I had conducted interviews with many extensionists and project managers at several institutions about the specific nature of these communities, their reasons for working there, and their experiences with the projects (see Chapter 1). I also studied available documents and publications at these public and private institutions. When traveling, I would talk with many people (usually on boats) who were familiar with the areas and communities I was to visit. When in rural areas, I would ask the residents of one village about the socioeconomic characteristics of neighboring villages and what they knew about any other villages before my subsequent visits. This preparation provided me with valuable information before arriving at my destinations, greatly facilitating this study.

Application of Methods

The goal of the interviews was to learn about the nature of income producing activities and land use practices of the communities in order to understand what may have motivated communities to participate in the PNCC. Variation between poor rural communities affects choices about participation in poverty reduction programs (see Hentschel and Waters 2002). Initial findings from these interviews underscored the importance of understanding why communities had decided to participate in the PNCC and their responses to the methods of the extension agencies.

This study involved a number of sensitive topics. First and foremost was the Programa Nacional de Camu Camu (PNCC) itself. There was considerable local frustration with the PNCC, and especially the institutions that had been assigned to conduct extension work. This even involved grievances about the conduct of specific extension workers, or public officials. Group interviews often erupted into loud denouncements of the program. I had obtained lists of participating farmers from some of the institutions working on the PNCC. The locals were familiar with these lists, which they would ask to see. When I produced these lists, they often became upset to see that that their name was (still) on the list, because they said they had never participated in the project. There were also complaints about my presence, and the fact that many communities had been subjected to a multitude of interviews related to the PNCC over recent years. It was clear that some residents were tired of being interviewed and suffered from "questionnaire fatigue" (see Thiele et al. 1997, p. 281). At the same time, others were clearly anxious to express themselves, and take advantage of my presence to make themselves heard (see Bernard 1994).

Questions about the extraction of camu camu and the local revenue from wild harvests were also sensitive. Again, these questions also encouraged many people to use the interview sessions to eagerly explain their opinions and ideas about the wild harvests, access to the resource, and the marketing of camu camu. Other extractive activities such as hunting and timbering were also sensitive topics because they were usually illegal. The presence of armed forces (official or subversive), and the drug trade were delicate matters in some communities.

By meeting with small groups, individual families, and talking in the privacy of a garden, I had multiple, flexible opportunities to learn about the local history and circumstances confronting the people. The use of the methods in a variety of situations greatly facilitated communication and information gathering. For example, when group interviews conducted in villages invited tensions from onlookers, we could retreat to a garden for a more relaxed atmosphere.

Selection of Villages

My initial research and interviews with extension agencies indicated that except for experimental plots in uplands, the PNCC had been carried out with communities located exclusively in floodplain environments, or on the edge of the floodplain. The most reliable government report listed 76 villages participating in the PNCC in the region of Loreto (IIAP 2000). Official records from the region of Ucayali did not reveal the precise number of communities. Fifteen villages were listed, along with 7 concentrations of plantings involving an undetermined number of communities (Riva 2001). I conducted interviews in 39 communities; 34 in Loreto and 5 in Ucayali province. The communities were located in six primary areas of camu camu extraction and cultivation (Chapter 1). In these same areas, I also visited communities that did *not* have access to wild camu camu, and did not participate in the camu camu planting programs.

The communities varied in distance to market centers and access to these centers. They were located within one day, two days and greater than two-day travel times from Iquitos markets. In Ucayali province, all were within one day from Pucallpa (Table 3-1). As stated in Chapter 1, the criteria for selection of these floodplain communities was also based on two hypotheses: 1. Communities with no access to wild came came would be more likely to participate in planting projects than those with access to the fruit, and 2. Communities located close (within 24 hours) to urban markets for came came would be more likely to participate in planting projects than those located more than a day from these markets.

Community Livelihoods: Income-producing Activities

Interview Results

The sample of 39 communities was mostly small villages of 30 to 60 families, although two had populations of over 150 families (Table 3-1). Eleven categories of primary economic activities were reported, including the sale of came came fruits (Table 3-2). The "traditional extraction" category refers to the extraction of non-timber forest products (such as palm fruits) and hunting (including turtle egg collection), but not fishing, charcoal, came came, or timber, which are separate categories. Eighteen of these 39 communities (46%) had access to wild stands of *Myrciaria dubia* and reported that they had harvested the fruit for sale (Table 3-1). The groups of informants were asked to decide upon at least two primary income-producing activities in order of importance, with most providing two to four categories of activity. While there was considerable heterogeneity of income-producing activities and specialty products in these communities, results indicate they tend to rely heavily on just a small number of income-producing activities. For example, agriculture was reported to be the first or second most important activity in two-thirds of the villages (67%), and fishing was first or second in importance for more than half (56%). This is not surprising, given that all villages were located on riversides or the floodplain, where soils are fertile and fish are available. Still, there was considerable variation in income-producing activities, as no single category was reported to be first or second in importance to more than half the communities.

After agriculture and fishing, wages were reported to be first or second in importance in eight of the communities (21%), while came came harvests were first or second in importance in six communities (16%). Charcoal production was an increasingly important income-producing activity in several villages, while traditional flora and fauna extraction was reported to be of limited overall economic importance in these communities.

The importance of income from came came makes sense, since almost half of the communities had access to wild stands and had marketed the fruits on at least one recent occasion. The importance of wages to communities was at first surprising, as few obvious signs of sources of wages existed in most communities. This topic will be discussed later in the chapter.

Illegal Sources of Income

I found that the economic importance of some income-producing activities was a sensitive topic, and may have been underreported by the people. This was because of the illegal nature of much of this activity. Hunting for commercial purposes was illegal, as was turtle egg collection. Most of the timber extracted was reported to be illegal. It was important for me to take note of shotguns, chainsaws and tools in order to better question residents, who tended to minimize the extent to which these activities occurred. Commercial charcoal making had recently been prohibited by the government, making some people less than open about the extent of local involvement in this activity.

The drug trade was economically important to some communities, although this is not a category in Table 3-2 because most residents did not want have their community portrayed as dependent on this illegal activity. Communities on the Putumayo River were involved in aspects of the cocaine business. Since the arrival of large contingents of Peruvian military in the last five years, residents reported that most coca fields were eradicated on the Peruvian side. The people explained that it is quite easy for young men to find work on harvesting coca fields and processing leaves on the Colombian side. An interview with Catholic Church clergy in El Estrecho confirmed this. Some residents of Jenaro Herrera were also involved in the drug trade. For this dissertation, the wages category in Table 3-2 does not include any wages from the drug trade.

Another sensitive issue for communities on the Putumayo River was the Peruvian and Colombian military, and the presence of three armed movements. Despite claims to the contrary by the Peruvian government (e.g., La Republica, July 17, 2002), residents reported that the FARC and ELN visited and traded with villages on the Peruvian side of the river. Pro-government Colombian paramilitary groups were also in the area. I repeatedly asked what residents were doing with livestock and they replied they were selling it for good prices to buyers who visited them frequently. This was usually not to the Peruvian military, but to the FARC and ELN[1]. Supporting this, Soregui (2000) does make brief mention of the presence of the FARC and the drug trade in Putumayo communities. The economic impact of the drug trade and armed forces in these communities was no doubt significant. At the same time, this information is valuable because it illustrates how communities in the sample were adapting to challenging socioeconomic realities.

Income-producing Activities: Discussion

Land use and Local Specialization

The interviews revealed that these communities tend to specialize in certain activities, and may practice distinct forms of land use quite different from that of neighboring communities. For example, on the upper Tahuayo River, the village of Punga has specialized in cultivating a type of a purple yam (*Discorea trifida*), while the adjacent village of Santa Cruz is well known for its hogs. Close by, the village of Esperanza has practiced a unique form of avocado cultivation on high restingas located within shaded forests for more than 60 years. My informants explained how other nearby communities have tried to mimic these lucrative activities with little success. This situation illustrates the unique skills of the farming families, as well as their ability to adapt to and utilize even very small, local variations in landscapes. It also shows how profound variations in local histories can occur within a very small area.

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[1] The Fuerzas Armadas Revolucionarios de Colombia (FARC) and El Ejercito de Liberación Nacional (ELN) are both fighting the government of Colombia.

Families are often unwilling to share the secrets of their success and their methods with others. For example, charcoal production is becoming quite common on the floodplain near Iquitos. Local experts are now charging significant sums of money to train others who want to learn the art of charcoal making. Previous studies have shown such variation in livelihoods between floodplain communities in the Peruvian Amazon, but tend focus on aspects of household wealth to explain this rather than these cultural and environmental factors (e.g., Barham et al. 1999, Tagasaki et al. 2000).

Variation and Change in Floodplain Communities

What Tables 3-1 and 3-2 do not show is how these income producing activities have undergone changes over the years, and can even be products of quite recent events. These changes are due not only to socioeconomic conditions, but biophysical changes in the environment. For example, changes in the course of the Amazon River during the last decade caused its waters to flow into the lower portion of the Tahuayo River. Communities that were accustomed to fishing in a black water environment suddenly found themselves in a sediment-rich, white water environment. Valuable black water fishes were no longer there[2], and heavy sediment deposits damaged riverside fields, resulting in a significant loss of income. Responding to these changes, communities now rely more on income from making charcoal, growing tree crops such as cashew and uvilla (*Pouromura cecropiifolia*), and artwork made of palm fibers (chambira). Residents actively cultivate and manage the chambira palm (*Astrocaryum chambira*) in fallows for its fibers and fruit along the lower Tahuayo. Such diversity related to environmental changes over time in agroforestry strategies and NTFP exploitation resembles that described by Smith et al. (1996) for the Brazilian Amazon.

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[2] These include gamitana (*Colossoma macropomum*), paiche (*Arapaima gigas*), tucunaré (*Chicla ocellaris*), and fasaco (*Hoplias malaabaricus*).

Recent changes in the flow of the Amazon River have also ended most rice production in the island settlement zones of Timareo and Nuevo Progreso, once their major source of income. Taking advantage of their proximity to Iquitos, these villages have switched their efforts to cultivating high value fruits such as papayas and vegetable crops.

Changes in the economic value of natural resources have recently benefited some communities, while others have endured conflicts. An increase in tourism during the 1990s has benefited villages such as Chino, Buena Vista, and Padre Cocha. Pottery sales to tourists have created a new demand for special clays needed for ceramics. Near the Ucayali River, the village of Siete de Julio has deposits of the best clays, but conflicts have erupted with neighboring villages over access to this clay[3].

Higher prices for fresh fish have obligated several of these communities to patrol local lakes to defend them from outsiders, with varying degrees of success. At the same time, the people have invested in large thermoses and iced the fish to obtain better prices in urban markets. Then in the mid-1990s, 18 of the villages in the study area found themselves to again be the object of outside attention because they were located near a (suddenly) valuable natural resource; camu camu fruits.

Problems with Agriculture

Residents explained how adapting to changes in these communities has not been easy, nor have they always resulted in viable alternatives. Above all, the people reported that problems associated with agriculture have been most difficult to adapt to. For example, the high cost and restrictions placed on chemical inputs has reduced income for farmers who were dependent on these for intensive floodplain farming, especially farmers who have had to abandon rice production and rely on vegetables. Meanwhile, the out-migration of people from rural to urban areas has reduced available labor and raised the costs of labor in most villages. Near the city of Pucallpa, the village of Pucallpillo has experienced a recent drop in agricultural production because the seasonal plowing service provided by the government no longer exists. Invasions of leaf cutter ants ("curhuinzi") in Santa Cruz have made it almost impossible to farm lands adjacent to the village, and a lack of labor and credit now prevents most families from farming the more distant, pest-free uplands.

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[3] A nearby Shipibo Indian community now has an international market for their pottery, but must enter the jurisdiction of Siete de Julio to extract two types of clay needed for their work. Siete de Julio has demanded a payment for this clay, but the Shipibos refuse to do this, instead sneaking in at night to dig up the clay.

Communities are seeking ways to be productive that require less demanding labor, such as making handicrafts from chambira fibers. This activity can be done in the home and by children or elders. Farmers were shortening the time they leave lands in fallow because of the labor required to clear mature fallows. They stressed that this is promoting soil degradation and lowering crop yields. In these areas, charcoal-making has become popular largely because less labor is required than swidden-fallow agriculture, while utilizing tree species that are found on some of the most impoverished soils.

The in-migration of ribereños to the small towns of Jenaro Herrera and El Estrecho has crowded them with young people with little interest in farming, and a need for immediate employment. Jenaro Herrera residents relied heavily on agricultural subsidies and employment opportunities from several large development projects as the town grew during the 1970s and 80s. Once the projects left, this isolated town found itself in extreme poverty, as the unsustainable projects collapsed. [4] Some residents have even turned to drug production (cocaine) in order to make ends meet. In isolated El Estrecho, the only market for agricultural produce is local, and quite restricted. Public works projects there that flourished in the mid-1990s have slowed to a trickle, and the main source of income for new residents has been the employment opportunities that exist just across the Putumayo River in Colombia, where Peruvians earn good wages harvesting coca fields and processing the leaves. Both these towns are located near large stands of wild camu camu, which according to residents has provided nearly all local income during the harvest seasons in the last few years. We must remember that across all communities in the sample, agriculture was the most important overall income-producing activity, making it crucial for them to adapt to the challenges associated with farming and marketing their produce.

Human Adaptation to Changes in Amazonia

We have learned of just a few of the more recent socioeconomic and environmental changes that were reported to be affecting the communities in Table 3-1. What these examples illustrate is that floodplain communities of the Peruvian Amazon are not only characterized by the diversity of their inhabitants, or their extractive and productive activities, but also by continual changes in their natural and socioeconomic conditions. This recent, dynamic natural history of floodplain villages in the upper Amazon in Peru resembles similar processes of change found elsewhere on the Amazon floodplain as described by Goulding et al. (1996) and Smith (1999, 2002), who studied caboclo communities in the lower Amazon during the same period. Not all of these environmental changes are forms of degradation, and human adaptation to these changes has often resulted in the conservation and enrichment of local landscapes (e.g., the cases of avocado, chambira, and lake protection).

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[4] One will notice the Swiss-style buildings and abandoned pastures around this town, also the district capital. The town was to become a major cattle and dairy production center for the region. Cheese is produced by a handful of families who still have cattle, and sold to people on riverboats that stop at the port.

Small-scale farmers are often said to be resistant to change and experimentation (Prain et al. 1999). Although some regional studies of the Peruvian Amazon have noted a lack of farmer experimentation on the floodplain- most notably Chibnik (1994); or warned that agricultural policies were driving farmers to abandon a diverse set of agroforestry practices for cattle (Coomes 1995), results from the interviews conducted in this sample of 39 floodplain communities indicate otherwise. Environmental, economic and social relationships in these rural areas are continually evolving and can be unpredictable. At the same time, the communities are not passive observers of these changes. Most ribereños have shown an ability to adapt to these changing circumstances, and when possible, work them to their benefit.

The Recent Boom in Rural Development Projects

A recent change in these communities is noteworthy. Bilateral support from developed countries and international finance sources has poured in to Peru during the last two decades, largely supporting government initiatives (Banco Mundial 2000). By the early 1990s, Peru was restructuring its economy under President Alberto Fujimori. Widespread agricultural credit programs had ceased, and the rural poor were anxious for some sort of government support (see Casa Campesina 1985, Chibnik 1994, Coomes 1996). But the Fujimori administration had little taste for agricultural credit. Instead, rural infrastructure would be the priority, spearheaded by a program called FONCODES[5] . The new FONCODES program paid poorer Peruvians a daily wage to repair and build badly needed infrastructure throughout the country. In Loreto, a province with less than one million inhabitants, FONCODES completed 1908 development projects during 1992-1999. FONCODES also provided food rations to school children in 460 rural villages (Ancajima 2000).

Fujimori also had his Ministry of the Presidency take control of the Instituto Nacional de Desarrollo (INADE) and created a similar development program in Amazonia that was aimed at the most isolated rural communities. At the same time, there was boom in the number of conservation and development NGOs working in rural areas (Chapter 1). This increase in NGOs in Latin America has been nothing short of explosive in the last two decades (Bebbington and Thiele 1993, Fisher 1993), and Peru is no exception, with a list of some 900 of these institutions (Meyer 1999).

Despite frustration with the lack of economically viable agricultural options or government support in this sector, farmers informed me that they were very happy to earn FONCODES wages in comparatively easier work building schools, health posts, bridges, water tanks, outhouses, sidewalks, and other infrastructure for their communities. The standard daily pay with FONCODES was 10 nuevo soles for laborers (2.86 – 3.00 USD), and could be much more for local project leaders[6]. Work crews were rotated. so that all community households could benefit.

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[5] Fondo de Compensación y Desarrollo Social. Although considered by the authorities to be an NGO and funded with help from foreign sources, FONCODES was in practice an arm of the government. Educated Loretanos were also paid well to direct these projects all over the region.

[6] Inflation has been very low in Peru since 1993, so the wage remained standard.

Many people I met proudly spoke of these improvements, and their experiences working for FONCODES and other institutions. In this study, only the village closest to Iquitos (Moena Caño) and the newest settlement (San Gerardo) had not been recent beneficiaries of FONCODES, INADE, or other wage-paying development projects. Ironically, as the building continued most of the communities reported they were experiencing a drop in population, as supported by Soregui (2000), and some of the new schools remained quite empty of pupils.

Most of the FONCODES programs in these communities had ended by the year 2001 due to political changes in Peru. However, wages were still the first or second most important income producing activity in more than twenty percent of the villages (Table 3-2). Ten communities reported that wages from agencies other than FONCODES were significant sources of income for them. This is because the practice of paying wages by the FONCODES projects had forced most of the other development agencies to find ways to compensate people for working with their projects. However, these benefits (they could be in the form of cash) were rarely, if ever distributed as widely through communities as the FONCODES wages were. There were frequent complaints that these projects were exclusionary, and would favor certain families or individuals.

Cash Earnings and Social Changes

From the comments of the ribereños, my own observations led me to believe that the importance of development project payments to communities was perhaps far greater than the formal interview process had indicated. For example, I learned that during the 1990s, these communities began establishing fixed prices for natural resources that were normally traded between people. Fish and game suddenly had local prices, and not surprisingly the sellers were often people who were the least involved in the paid projects. For example, fresh fish was usually 2 soles a kilo on the upper Tahuayo, and 2.5 soles for salted fish. In the Putumayo River, fish and game were very abundant. In the isolated village of Santa Mercedes fish was sold for 4 or 4.5 soles per kilo, twice as much as anywhere in the study. These exceptional prices may be due in part to the presence of drug money or guerillas, but most of the families had earned monthly wages for more than five years working for the INADE sawmill. Those who did not work in the sawmill spent their time hunting or fishing and then selling their take to the others.

The custom of trading ("cambio", "treque", "calambique") was still very common in all these communities. However, local cash economies had certainly become prevalent, largely due to the influx of cash from development projects, and the growing portion families who were in need of cash to help finance family members living in small towns or urban centers. This change seems to have promoted the monetization of the traditional, reciprocal system of agricultural labor, known as a "minga". Mingas involve the more difficult and labor intensive work such as weeding fields or clearing forest to start a field. In a minga, groups of 10 to 20 people would work in another family's field with food and beverage being supplied by the host family. When another family needed such help, the group would then work in their minga (see Padoch and de Jong 1989).

Since the rural credit programs in the 1980s, there was often local pay for agricultural labor. But now, farmers complained that even mingas were more a matter of cash rather than reciprocity, and that the cost of labor for the new "mingas" in their fields was reaching that of a FONCODES wage. Young ribereños were reported to be particularly disrespectful of mingas and demanding about wages, while performing poor quality work. In these communities, agriculture remained a vital means of subsistence and income, but now under different socioeconomic conditions. Several studies of ribereños in the Peruvian Amazon have noted their ability to adapt to changing environmental and economic conditions (e.g., Hiraoka 1986, Padoch and de Jong 1989, Coomes and Burt 1997, Barham et al. 1999). Such studies have tended to overlook the underlying social causes of these changes. In this dissertation, we again see local adaptation to such changing conditions, many of which are largely in the form of social changes such as armed conflicts, the cocaine trade, and demographic pressures. Such social change now includes new attitudes about money and work, which in turn affects agricultural practices.

Community Participation in Camu Camu Planting: Interview Results

The Decision to Participate in the Program

Thirty-one of the 39 communities in the study (80%) participated in the PNCC. "Participation" meant that at least 10 adults from a village would form a work and agree to plant camu camu under the direction of one of the institutions carrying out the PNCC. At least 24 institutions and organizations (governmental, NGOs, or private) were at some time responsible for executing the planting program for the government during 1996-2001.[7] Asked to give the two most important reasons for their decision to participate as a community in the program, the people gave eight principal reasons as their first answer (Table 3-3). In 21 of 31 communities (67%) the people reported the main reason they had done so because they expected either monetary aid ("apoyo") or credit to help them plant and maintain the new tree crop. In 17 of 31 communities (55%), the people reported that aid or credit was their second reason for deciding to participate.

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[7] There were 11 organizations working in the Region of Loreto and 13 in the Region of Ucayali (Riva 2001). Some figured prominently in the program during the first years, and then quietly exited or were deliberately dropped from government recognition and PNCC figures (e.g., Peru-Canada and WWF). Private industry and individuals, plus a few other NGOs also planted camu camu, but were not officially part of the PNCC. These efforts are not included in this study except where specifically mentioned.

Three communities reported the main reason they had decided to participate was to have an additional income, while four reported this as their second reason. Promises made by NGOs were also a reason for the participation of four communities in the PNCC. No other specific reasons for participating were given by a significant number of communities. Collectively however, the economic promise of the fruit was an important reason why 12 of the 31 communities (39%) reported that they had decided to get involved in the program (to have an additional income, high price of camu camu, permanent buyer/industry).

The Decision Not to Participate in the Program

I then asked these same groups why members of the community had *not* participated in the project. Residents were again asked to give the two most important reasons for this decision. They gave nine reasons as their first answer (Table 3-4). In 16 of the 31 villages (52%) it was reported that the main reason people had not participated was because no aid was offered to help them plant and maintain the new tree crop. Here they explained that simply a lack of aid was what made community members decide not to participate, whether in the form of a gift or credit. This response was given as the second most important reason in 12 villages (39%). As with the camu camu planters, these responses also indicate the strong desire across communities in the sample for direct monetary assistance to accompany participation in the PNCC.

Significantly, 11 communities (36%) reported forms of dissatisfaction with the extension institutions as the second reason residents had decided not to participate, and four communities (13 %) gave this as their main reason. Residents in four communities (13%) had not participated because they felt they already had plenty of wild camu camu fruit to sell.

Non-participating villages

Only eight of the 39 villages surveyed (21%) had not participated in the program (Table 3-1). However, this was not their decision, as they never had a choice in the matter. The people reported that "nobody came here", explaining that no institution had arrived or offered to work in the community. Seven of these communities reported that they were in fact quite frustrated that they were not at least considered for the program.

Community Participation: Discussion

Heterogeneous Communities and a Homogenous Response

Despite the heterogeneous mix of communities in this sample, local perceptions about the camu camu planting projects varied relatively little. Responses from the interviews indicate a very strong desire for direct monetary assistance to accompany the PNCC. This may at first appear to support the observation of Pinedo-Vasquez and Pinedo-Panduro (2002) that most ribereño families perceive camu camu planting programs as short-term financial opportunities rather than a viable livelihood alternative. However, only three participating communities stated that camu camu cultivation was especially difficult work, and only two communities criticized its economic potential.

The reasons why farmers may ultimately adopt tree planting and agroforestry practices has much to do with local social conditions at particular historical periods (Belsky 1993). Given the recent history of the region, the demand for assistance with this new agricultural endeavor is not surprising. The absence of credit is also a major constraint to expanding agroforestry in the Brazilian Amazon (Smith et al. 1998, Vosti et al. 1998). Moreover, where agroforestry systems have recently been shown to work as a rural development option in Amazonia, paid labor was a necessary input for their success (e.g., Yamada and Gholz 2002).

The ability to market products from agroforestry systems is a key factor influencing farmer adoption of these systems (Nair 1993, Smith et al. 1998, Vosti et al. 1998). The sudden jump in demand and price for wild camu camu fruit had caused some excitement in the region. Twelve of the 31 communities (39%) reported that the economic promise of the fruit was an important reason why they had decided to get involved in the program. This fact casts additional doubt on the claim by Pinedo-Vasquez and Pinedo-Panduro (2002) that most ribereño families do not perceive camu camu planting as a viable livelihood alternative.

Access to Wild Camu Camu and Markets

In four of the 31 participating communities (13%) the people explained that they had not participated because they felt they already had plenty of wild camu camu fruit to sell. It is logical to assume that communities with no access to wild camu camu would be more likely to adopt the crop than those with access to camu camu. Still, these same villages had also formed groups of planters with the extension agencies.

It is also logical to assume that communities closest to markets would be more likely to participate in the planting programs than those located multiple travel days from markets. Most of these communities depended upon slow riverboats with unventilated hulls to transport their produce. Twenty-two of the 31 villages (71%) participating in the PNCC were located more than a one day from market and the other nine communities were located more than two days away. However, such hypotheses were impossible to test at the community level because all 31 in the sample that were approached by extensions agencies had quickly agreed to participate, mainly because of the aid that had been promised to the community. Thus, even the communities furthest from markets in the study had agreed to participate in the study.

Institutions and Community Participation

The responses from the communities listed in Tables 3-3 and 3-4 provide a number of insights about the institutions directing the camu camu planting. Besides the lack of aid or credit, almost half of the participating communities reported additional forms of dissatisfaction with extension agencies as the main reason people had decided not to participate. There were numerous complaints about broken promises and ineffective extension work. The people frequently expressed anger about the way the projects were conducted and even about the personalities of the extensionists. The word "deception" was commonly used to describe the practices of these institutions, and was also a common reason why community members to did not want to participate. Perhaps more importantly, six of the 31 participating communities explained that they viewed these institutions and their projects as failures to begin with due to their previous experiences with them. At the same time, community members who may have wanted to participate felt left out from the process. In five of these communities, non-participants complained about their exclusion from the project, and especially about the way these groups selected or excluded participants. The most common reason for this exclusion was that the NGOs favored the participation of their members from other projects they had previously initiated in these same communities. This even led to conflicts and resentment of the groups of planters in communities. This situation resembles that described by Morshed (2003) in Bangladesh, who found that the rush by NGOs to implement programs perpetuated factions and conflicts in rural communities.

This exclusion from the camu camu planting programs was not only limited to members of participating communities. Entire communities were excluded from the PNCC. As explained previously, they never had a choice in the matter. Seven of these eight villages were frustrated that they were not at least considered for the program, including Marandúa, Colombia[8]. Residents from the other 6 non-participating communities in Peru[9] told me that they had sought out and actually met with extensionists, and repeatedly invited them to work in their village. However, they never came. When I inquired about this, some of the NGOs confirmed this to be the case. This seems surprising, especially since most of these neglected villages were host to very few other projects, and were anxious to work on development projects. At the same time, extensions agencies were very interested in boosting both their numbers of participants and trees planted, and could have done so with these villages.

Five of these neglected communities were also located close to the camu camu market and processing center of Iquitos (in 2 cases less than 1 hour away). Some were even located next to villages that were part of the PNCC. Moena Caño, Jaldar, and Nuevo Jerusalen were very poor villages with no access to uplands, and explained that they had wanted to try camu camu planting because they were in vital need of increased agricultural output from their seasonally flooded environment. Aside from their needs, these excluded communities had considerable experience cultivating fruit trees, making them ideal for experimenting with a new tree crop [10].To Black (1991); such paradoxical situations are all too common in the practice of development.

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[8] INADE officials informed me that they had planned to work with communities on the Colombian side of the Putumayo River in a joint effort with the Colombian government, but the Colombian project (SINCHI) was cancelled.

[9] These were: San Pedro, Jaldar, Nuevo Jerusalen, Padre Cocha, Moena Caño, and Flor de Agosto.

With agriculture, success of extension activities depends largely on extension agents and their relations with farmers (see Rivera and Zijp 2002). Extension agencies in the PNCC had produced impressive lists of participants and the area that was supposedly planted in camu camu (e.g., WWF 1998, Ministerio de Agricultura 1999, IIAP 2000, INIA 2000). Their projects may have intended to do so, but the ribereños hardly responded, and most quickly abandoned this effort (Pinedo-Vasquez and Pinedo-Panduro 2002). In most of these communities, I found that only one or two small fields of *M. dubia* were maintained, and in some communities, none at all. Conversely, I found that close to Jenaro Herrera and Yarina Cocha, at least four fields of camu camu were maintained in each community. Some of the ribereños had praise for two extensionists who had worked in these specific areas. These extensionists had worked in the communities on other projects for several years before the PNCC began. This highlights not only the value of quality extension workers, but the importance of personal relationships between extensionists and community members. It also shows the propensity of villagers to cooperate with rural development programs when they have prior experience working together in past situations (Walters at al. 1999).

Although the PNCC was touted as a rural development program to alleviate poverty, the findings from the interview process suggest that the institutions in the program had their own criteria for selecting communities that was not based on important factors such as local poverty and needs, land resources or access to markets. Pace (1998) believes that there has been a history of this practice by development organizations in the lower Amazon[11]. Loker (2000) found these same problems with tree planting projects designed to alleviate poverty in Honduras.

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[10] Even the town of Tamshiyacu, which was surrounded by PNCC projects and just three hours from Iquitos, was not included. Tamshiyacu residents are well known for their tradition of cultivating fruit trees.

Scaling Up and Community Participation

Initiating Community Participation

Findings from the interviews discussed so far along with the assertions of Pinedo-Vasquez and Pinedo-Panduro (2002) about camu camu planting raise an important question: How did people respond to the PNCC in their communities, and what explains this? Normally, around 12 to 20 farmers from a village would form a work group that agreed to plant camu camu under the direction of one of the extension agencies carrying out the PNCC in rural areas. The institutions directing the project in the study area used a "training and visit extension model." This top-down method provides little support for farmers, and works as a one-way channel (Chambers et al. 1989, Carney and Farrington 1998). Camu camu seeds were provided to all participating villages, and nurseries were quickly made to raise seedlings. Each member of the group was supposed to make at least one hectare of floodplain land available for camu camu. Once the seedlings were ready for planting, they were distributed to members of the project and planted according to extension recommendations.

Camu camu was interplanted mostly with annual crops in these fields (see Pinedo-Vasquez and Pinedo-Panduro 2002). The farmers were trained to follow a standard planting script[12], and expected to assist one another with field preparation, planting, weeding, and hold regular planning meetings. Extensionists would arrive periodically to assist the farmers, mostly by walking through fields, examining progress, and explaining any adjustments that were deemed necessary. They spent relatively little time with the farmers, and moved from village to village as fast as possible. This training and visit extension model was common for rural development projects in the region. Meanwhile, farmers were either stuck with a big commitment, or contemplating such a commitment. Some tried to pressure other community members into deals to obtain the land necessary for their participation. It was no wonder that communities were anxious for additional help with the project. What is unclear is if the extensionists comprehended their needs.

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[11] Tedi Peña Herrera, CARE-Iquitos Director (1995) told me CARE avoided villages with problems of poverty and organization.

Challenges of Scaling Up

As shown in the previous chapter, institutions in Peru already had considerable experience cultivating camu camu in experimental plots. The government then set out to cultivate *Myrciaria dubia* with 10,000 small farmers in the regions of Loreto and Ucayali, Peru, during 1995-2005. The goal was to plant 10,000 hectares of camu camu, meaning one hectare per family, in floodplain fields, preferably in low *restingas*[13]. The trees were expected to begin fruiting after three years (Riva and Gonzales 1997, IIAP 2001, Pinedo-Vasquez and Pinedo-Panduro 2002). This is an example of very rapid scaling up in a tree planting program, requiring the cooperation of local farmers and extension agencies to promote this scaling up (see Franzel and Scherr 2002). At the same time, the interviews show how there was considerable dissatisfaction with the extension agencies themselves in these communities. Additional dissatisfaction now developed over problems associated with this scaling up.

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[12] The standard planting distance was usually 3 by 3 meters (1111 trees/ha), especially if intercropped with manioc. Some projects preferred a distance of 2 x 3.

[13] Restingas are old fragments of river levees that rise slightly above the lower expanses of the floodplain. These are preferred locations for agriculture on the floodplain, where farmers intercrop annuals and practice agroforestry.

Farmers encounter many problems experimenting on a large scale: i.e., with an entire field. A farmer who tries out a new technology with a small-scale test (rather than an entire crop) has much less is at stake This is why most farmers experiment with new crops using a homegardens or a step-wise plan, to test results and reduce risks (Bunch 1989, Prain et al. 1999). Farmers in Amazonia are well known for experimenting with new crops in their agroforestry systems, and especially at first on a small, experimental basis in their homegardens (Smith 1996, Smith et al. 1998). With the PNCC, farmers were being pressured into dedicating 1 hectare of valuable floodplain land to camu camu cultivation.

It is not only farmers, but development programs and institutions themselves that encounter many problems attempting to rapidly expand their programs (Morshed 2003). Small scale experimentation also helps the extensionist preserve his credibility and prestige, two assets frequently lacking in agricultural extension service. This makes their work easier, and they can also reach more people (Bunch 1989, Prain et al. 1999). Under pressure from extensionists, the farmers had no flexibility in responding to the arrival of the new program. They either planted one hectare or were not members of the program[14]. The very nature of agroforestry systems requires that farmers need and take time in their decision to commit to planting trees (Rocheleau et al. 1989). Some of the institutions now in the PNCC already lacked local credibility, and the ribereños were leery of participation due to past failures with these groups. This helps explain why communities were insistent upon some form of financial support before committing themselves. As Morshed (2003) found with rural development projects in Bangladesh, it seems that pressure from the top on both farmers and extensionists to quickly advance the PNCC may have hurt participation in the program more than it helped.

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[14] Several farmers told me they had wanted to plant small plots of camu camu, or even one-half hectare, but were dismayed because this effort would not be recognized as sufficient for membership in the planters groups, or any benefits that might be offered.

Managing of the PNCC and Different Interests

Support of the PNCC: Institutions

Pace (1998) criticizes the preference in Amazonian development projects for placing elite interests over local needs. Where did the support for the PNCC go? To stimulate industrial development, the Ministry of Agriculture coordinated the cultivation of camu camu fruit in the PNCC beginning in 1997 with a government development agency called Unidad de Desarrollo de la Amazonia (UDA). In order to promote a "chain" of production from the farm to the factory, a major investor in the camu camu export business, Carlos Santillan Angulo, was appointed to head the Asociación de Productores de Camu Camu de Loreto (Ministerio de Agricultura 2000). This was an association that was to be made up of small groups of planters (usually a group from each village) who would register with the government and use their new association to obtain financial aid, land rights, and other benefits. As the results from the interviews indicate, such support never came. In fact, these planters associations were rarely, if ever recognized by the government. Meanwhile, Santillan and his partners were given government loans, tax incentives, and special export status while they ran the largest camu camu processing firm in Iquitos. This situation was thus another example of what Pace (1998) criticizes as a preference in Amazonian development projects for elite interests over the needs of the local population.

The government had annual budgets for the PNCC in the regions of Loreto and Ucayali, with headquarters in both regions (Iquitos and Pucallpa). The Ministry of Agriculture had an annual budget from 2.8 to over 5 million soles for the project in Loreto[15] (800,000 – 1.5 million USD), and contracted several organizations to do the planting work (PNCC 2002). International funds, especially from Canada, Winrock International, and Hughes International also supported the PNCC and some of this went directly to NGOs. Anxious to get their hands on this funding, these institutions dropped ongoing projects and quickly committed themselves to installing a certain number of hectares of camu camu in textbook fashion that were expected to produce fruit within three years. Funding was based on the levels of participation and size of the projects.[16] Others simply carried out preliminary studies on camu camu planting and wrote up plans for planting the trees. Regardless of the integrity of these institutions, this opportunistic and entrepreneurial type of interest is increasingly common in Latin America (Bebbington and Theile 1993, Fisher 1993, Meyer 1999), and the PNCC was no exception.

Black (1991) would have us believe that such narrowly focused interests are the unfortunate product of planning by large, top-down government organizations that milk the system to their benefit. However, the institutions assigned to carry out the PNCC were not comprised of large numbers of people. Most efforts were relatively small, with some NGOs such as World Wildlife Fund and CARE assigning just one or two field extensionists at a time to the project. The same was true for private firms such as

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[15] 3.5 nuevos soles = $1 US

[16] Several other government officials mentioned this, and everybody knew this, but it was impossible to obtain precise figures on the actual deals that were made. I was told, for example, that NGOs had received budgets averaging 1000 soles (286 USD) per hectare of camu camu to be planted Jakkar Tello, Director PNCC-Iquitos, personal communication. 2002.

CAMPFOR[17]. The PNCC-Iquitos unit run by the Ministry of Agriculture employed just four extensionists by 2001, and had eight field extensionists only briefly at its peak. Office personnel were also few in number. The PNCC-Pucallpa had a similar number of employees.[18] Findings here show that while these institutions and contracted agencies certainly took advantage of the boom in funding for camu camu planting and were top-down in the nature of their extension work, they were *not* large organizations, and some were private entities.

Community Expectations and Aid

We have seen that the PNCC had several sources of funding, so it is not surprising that state agencies and NGOs used economic incentives to attract as many farmers as possible to plant camu camu, as reported by Pinedo-Vasquez and Pinedo-Panduro (2002). However, the authors go on to explain that a lack of such support caused ribereños to quickly abandon the projects, which concurs with what we have learned from the interviews. This raises questions about these initial economic incentives: What were these economic incentives, and what happened with them? Understanding such details is crucial to advance our knowledge in order to improve effectiveness of extension and international development efforts Murray (1996)

I was told that many institutions repeatedly made false promises of aid packages to communities. How did this work? Camu camu planters in most villages received small amounts of food and occasionally cash payments to help them get started. Extensionists then explained that much more aid or credit was soon to come, if the people kept working. Project heads and politicians who visited projects also made promises of financial aid, gifts of farm equipment, and infrastructure. This fueled rumors of big aid or credit packages for the region. Another tactic that was used to convince a village to plant the trees was to explain how other communities in the Peruvian Amazon had done so, and were given substantial aid because they complied, or had already made huge sums of money from selling the fruit.

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[17] Compania Amazónica de Producción Forestal

[18] Jakker Tello, Director PNCC-Iquitos, personal communication. 2002.

By the time these institutions reached a new location, the ribereños had often already heard the stories, so extensionists had to make bigger promises as they arrived at increasingly skeptical communities. Targeting the largest village on the Tahuayo River, CARE extensionists told the ribereños that $2000 in annual cash support would be given to each family for every hectare of camu camu they planted. Mere mention of this story still brings quite a reaction in Esperanza.

These tactics increased local excitement over camu camu at first, but in the long run it probably damaged these projects because it raised expectations in communities and extension agencies could not deliver on their promises. Paying people to do some of the first work was a common extension strategy, but people quickly grew frustrated when they realized that this aid would not be sustained. Extension agencies seemed desperate to please communities, but in ways that were insulting at times. Project representatives would show up to give out just half a bar of soap to the participants; or a box of matches, a can of milk, and very small amounts of rice or sugar. The ribereños told me that this type of "aid" was not appreciated, and was offensive to them.

Reports from the communities made it clear what had happened; they had been given false promises of aid[19]. With such behavior on the part of project promoters, it is no wonder that many ribereños may have viewed this development project purely as a financial opportunity rather than an alternative crop, as Pinedo-Vasquez and Pinedo-Panduro (2002) insist.

Camu Camu Planting in the Field

Tall Tales and Dead Trees

Regardless of the amount of preparation in agroforestry projects, the expansion of new techniques into the field with farmers is crucial for their success (Franzel and Scherr 2002). However, few studies of tree planting describe what occurs in the field or attempt to evaluate such work. Most reports tend to simply give number of trees planted or the area planted (Scherr 1992). Murray (1996) and Loker (2000) are some of the few studies that focus on the actual chain of events in the execution of tree planting projects with small farmers in Latin America. They note the importance of paying attention to detail with what actually occurs during interaction between extensionists and farmers if we are to evaluate the effectiveness of extension work and advance progress in these projects. The directors of the PNCC offices had told me that extension agencies had "made a game" out of the camu camu planting program. They voiced considerable frustration but provided almost no details or specific examples about what had gone wrong. What, for example, had happened out in the field that limited the success of the PNCC?

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[19] It is unclear if these organizations knew if substantial aid or land rights would in fact ever be given to the camu camu planters. My interviews with their representatives indicated that such help was never a serious consideration, and they seemed strongly against any form of credit.

I learned the details about the actual tree planting process mostly through the ribereños. For example, the Comite de Reforestación of Ucayali province (a government agency) found itself with a truckload of camu camu seedlings one afternoon after being unable to convince a community to plant them. Across a long, narrow inlet ("tipishca") of the Ucayali River, the people in the village of Ega spotted the truck. It was a very dry year, and the inlet was now dry. Needing to send their produce to market, the people signaled the truck, which drove across the inlet to meet them. This was the first motor vehicle to ever arrive in the village. As excited people crowded around the truck, an extensionist explained it was full of valuable camu camu seedlings, some 20,000 for them. In Ega, the people practice intensive annual cropping with chemical inputs, and do not plant trees in fields (their response in Table 3-4).However, they were told they should join the project, and the people accepted the invitation, in return for a ride with their produce into Pucallpa.

Later that evening, an Ega resident who had gone to Pucallpa in the truck heard a rumor that a Japanese businessman was in the city and anxious to buy camu camu plants, and for big money. By early morning the people of Ega were in Pucallpa with all the plants they had been given. They never found the Japanese man, and the plants ended up dead, dumped in the city. Such disorder and treatment of seedlings is similar to that reported by Murray (1996) from tree planting projects in Haiti. Meanwhile, project records would show that another 20,000 seedlings had been distributed to farmers, another example of progress with the PNCC. The Comite de Reforestación eventually went back to Ega to check on the seedlings. After learning what happened, extensionists convinced the village to plant two hectares of camu camu for about $100 in total pay.

They did the work and were paid, but the field went to weeds due to a lack of interest in the community.

Extension agencies arrived with a great sense of urgency, working to get farmers to quickly establish fields of camu camu, This urgency required that planting stock was made immediately available to communities. Camu camu processing plants were required to distribute the waste seeds free of charge to the extension projects. This made it easy to establish plots of camu camu seedlings in communities, usually by simply spreading masses of seeds on the ground. Like the case with Ega, actually planting the camu camu in fields was a more challenging task. Extensionists would get the ribereños to agree to plant camu camu, and return later, expecting to see neatly planted fields. Notified that NGO brass or public figures would inspect their projects, the project participants would quickly plant seedlings into any clear garden or space they could find. If wild camu camu was growing nearby, they would simply tear out these plants and jam them in gardens. The ribereños laughed as they told me how these large, wild plants would impress the visitors. These frantic efforts to please authorities resemble reports from failed tree planting projects in Honduras as described by Loker (2000).

Deception worked both ways. Private entrepreneurs and "unknown" individuals suspected of belonging to the NGOs would hire groups of workers to tear out thousands of wild plants from local stands of camu came; never paying them as promised. Project participants were forced to sign documents they knew little, if anything about. Local leaders told me they had conflicts with extension personnel who had demanded that they sign documents saying they had received fertilizers, tools, and other materials that were never given out. To Bunch (1989), these are classic examples of credibility problems created by the extension agencies themselves.

Field Reports and the Effectiveness of Institutions

While extensionists are supposed to be catalysts of change, their true effectiveness is rarely evaluated. Scherr (1992) found in a survey of 108 agroforestry projects that less than half the institutions conducted impact evaluation. And for those who did, the evidence for effectiveness in extension was scanty. The majority evaluated simple variables such as the number of trees planted and area under cultivation, rather than indicators of true change in farmer practices. Much of the extension work for these projects was training and visit models based largely upon delivering messages to communities (ibid.) In the case of the PNCC, we again see this style of extension work and evaluation by these institutions. A look at the number of trees planted and area under cultivation reveals just how far these numbers games can go.

The Ministry of Agriculture reported that 5,384.43 hectares of camu camu was planted by 1999. Almost 75% was in Loreto, 25% was in Ucayali, with some 100 hectares in experiments in the region of San Martin (INIA 2000, Ministerio de Agricultura 2000). The Ministry had departments in Lima, Iquitos, and Pucallpa putting out these reports, while IIAP was also making reports in Iquitos and Pucallpa. Large discrepancies in the reports were common. Some reports gave figures as high as 5700 hectares, and 24,500 farmers, (Riva 2001). However, field inspections were occurring, and the government was increasingly aware that the 24 institutions had not all done their work as required. Meanwhile, IIAP had documented that just 982.5 hectares existed in

Loreto, based on the limited reports it had received from the extension agencies (IIAP 1999).

This situation prompted the PNCC to spend most of 2001 actually inspecting fields. They found that 1101.94 hectares of camu camu existed in Loreto, with just 472.5 hectares maintained in conditions capable of producing fruit (PNCC 2002). This figure represents just 8.7% of the 5,384.43 hectares that was reported installed by 1999. Another 629.16 hectares existed in poor condition, and was in danger of dying from lack of care. From what I had learned from the ribereños, these figures were not surprising. The Director of the Iquitos Program, Jakkar Tello, told me that even these figures were probably too high. He stated emphatically that the extension institutions had simply "made a game" out of the program, and most of the numbers on the reports were meaningless. Figures in this report did not name specific projects, but when comparing them to previous reports, I found that less than 5% of the camu camu that was reported to be installed in some areas had been verified as even existing in the latest PNCC inspections. (IIAP 1999, 2000, PNCC 2002). This evidence supports the claim of Pinedo-Vasquez and Pinedo-Panduro (2002); that ribereños had hardly responded to the camu camu planting projects.

The case of the PNCC in Peru questions the common assumption that NGOs and small institutions are more committed and efficient in their work than large governmental institutions (see Black 1991, Bebbington and Thiele 1993, Carney and Farrington 1998, Meyer 1999). It may be that their budgets tend to be smaller, but their work is rarely evaluated. Reports of NGOs from elsewhere in Latin America give details widespread corruption and waste in rural development projects (Loker 2000, McPherson 2003).

Measuring Performance of a Tree Planting Program

A major obstacle to effectively evaluating rural development projects lies in the qualitative and contingent nature of the work they do. Measuring performance is problematic; particularly with objectives such as "participation", "empowerment" and "development." Such terms are fraught with difficulty and abuse (Bebbington and Thiele 1993, Loker 2000, Brown 2002, McPherson 2003). Tree planting projects on the other hand, must produce tangible results[20]. In the case of the PNCC, an agreed upon area of trees was supposed to be cultivated at the required density by a specific number of families and reach productive stage three years after planting. In short, measuring progress of the extension agencies was simple. By 2000-2001, this had become a painful reality: A project either had the projected area of camu camu nearing production, or it did not. Colorful brochures would not work to impress people this time – the extension projects had to do what they said they were doing, and Japan was waiting for the fruit. With such clear parameters, the verification of progress by each institution was nearly impossible to debate.

This situation helps explain the persistent promises of aid to the communities by extension agencies and government officials. These were not just actions to compete with the recent FONCODES assistance and other projects. This was done not only to get people to plant the trees, but in a desperate attempt to please authorities and donors who had reports in their hands stating that thousands of hectares of camu camu had been established in rapid fashion on the floodplain. In this case, all parties involved would have to *demonstrate* to outsiders that they were doing exactly what they said they were doing. Thus, it is not surprising that several organizations ceased publicizing their involvement in the PNCC, and their names disappeared from government reports. The purpose of this section is not to dwell on the poor performance of extension agencies across this sample of communities. Virtually all rural development projects are problem-ridden (Walters et al. 1999). Non-governmental organizations are well known for being weak in monitoring their own actions (Bebbington and Thiele 1993). However, the unfortunate lesson here is that this experience in Peru may kill the appetite of these institutions for tree planting projects in the future.

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[20] An exception to this could be tree planting for the purpose of aesthetics.

Institutional Criteria for Selecting Location of Projects

The previous section of this chapter has focused on a critical analysis of the PNCC on its own terms; that is, in terms of its stated goals as a tree planting program. Yet, these examples from 39 communities are part of a larger development program that proposes the rapid integration of the region into a new international economy with the export of camu camu. To promote the adoption of agroforestry systems, planning agencies must influence the geographic location of these projects in accordance with development objectives, including marketing (Vosti et al. 1998). The goal of the PNCC was to supply an export industry with fruit and alleviate rural poverty through the cultivation of the fruit. This suggests that planners would target the poorer communities and those that had abundant floodplain lands to farm. Ideally, efforts would be made to cultivate the fruit in communities located relatively close to markets or processing plants. They would avoid communities where several development projects already existed. As shown in this chapter so far, however, this was usually *not* the case. There was a consensus that the PNCC should apply to floodplain communities; but what criteria were used to determine exactly where the program would take place?

Access to markets and extension agency planning

Planners in Peru were well aware of the perishable nature of camu camu fruit. Peru has a history of problems with transporting produce to markets and supplying agroindustry, especially high costs and delays (Naciones Unidas 1993). The isolated location of wild camu camu was already an overwhelming logistical problem for the fledgling industry. The economic potential of camu camu would be severely limited without significant improvements to transportation infrastructure (Peters et al. 1989b). Still, the PNCC proceeded to plant *M. dubia* in communities that were located far from markets. Table 3-1 shows that in this study, 22 of the 31 villages (71%) participating in the PNCC were located more than a one day from market and 9 of these communities (29%) were located more than 2 days away.[21]

Fruits from the INADE project in Santa Mercedes could only be sold if a buyer came to this extremely isolated village. The IIAP project in the Jenaro Herrera area was located on the outer limits of where camu camu could be shipped by boat and still arrive in satisfactory condition in Iquitos; even under the best of circumstances. Fruits harvested in the area constantly arrived in Iquitos in damaged or spoiled condition. Meanwhile, floodplain villages located just one hour from Iquitos such as Manacamiri and Moena Caño had asked the Ministry of Agriculture to join the project, but were turned down.

A major strength of NGOs lies in their autonomy and flexibility to plan and conduct their projects, especially compared to government institutions (Bebbington and Thiele 1993). Unlike the aforementioned state institutions, would they target specific locations that might facilitate the transport of camu camu fruits to market? World Wildlife Fund (WWF 1998) planted camu camu with the villages participating with their conservation program located within the Reserva Nacional Pacaya-Samiria. Camu camu was to be a major development project for these floodplain villages. However, most of these villages were located several days away from Iquitos, and the people had to paddle days in canoes just to reach riverboat transport. The WWF strategy was to have producers reach boats that the Backus and Johnston Brewery sent down each year to an area near the town of Requena. Still, the brewery had no agreement with WWF, or guarantee that this would be done even during wild camu camu harvest times. The boats were already notoriously unpredictable in their arrival dates when wild fruit was harvested by the local people. Entire harvests were lost. WWF personnel even admitted to me that their planning was very deficient in this respect.[22] The Peru-Canada project based near Requena also had the same problem. By 2001 some of these fields were producing camu camu, but the nearest processor was in Iquitos. Unable to sell fruit to Backus and Johnston, producers tried to market camu camu seedlings, with dismal results.[23]

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[21] The time given in Table 3-1 is travel time in boat. and does not include time needed for the fruit to be harvested and ready for transport on the riverside, usually the day before the day before the boat arrives. This time also assumes the boats trip does not experience delays, which are common. Thus, these are minimum travel times, under the best conditions, and an additional day for harvesting should be added to these times when considering perishability.

Ironically, the PNCC had promoted its Productive Chain program for camu camu ("Cadena Productiva") with no strategy is spelled out about how farmers would get their fruit to market, or how the PNCC considers the importance of location in the planning process. The NGOs that were contracted were under no apparent restrictions in this respect. My persistent questions and comments about this important issue went unanswered. The Proyecto Bioexport-Camu Camu researchers at IIAP acknowledged this problem, but had no apparent plans to promote camu camu planting in more accessible locations. At the same time, it seemed odd that the institutions directing camu camu projects located less than a day in travel time to Iquitos and Pucallpa never mentioned the comparative advantage of market access that their project offered, despite the fact that these farmers had a distinct advantage over others in the PNCC. The *farmers* certainly talked about this, and the prices they were charged to send produce to market. Except for WWF, extension agencies seemed largely indifferent to such logistics and transportation costs.

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[22] Javier Aguilar, WWF-Iquitos, personal communication, 2002.

[23] Alfredo Masuka, main producer, personal communication, 2002.

Community Poverty and Land Resources

If access to markets was not a concern when targeting villages, what about efforts to target land-rich or especially impoverished communities? As WWF did with camu camu planting, CARE followed a similar pattern of simply working where they had already worked on other projects. CARE had an agroforestry program in the Amazon and Tahuayo Rivers called "CASPI"[24]. But failures with CASPI had made communities hesitant to start another project with CARE. Furthermore, floodplain lands were often in short supply in CASPI project area, and it was a major reason why members of three communities had decided not to participate (Table 3-4). The NGO now set out to use the local floodplain for the new camu camu project. These villages were usually also the site of several other projects, including additional CARE projects[25] .

We have already learned that state extension agencies also tried to convince other land-poor communities to plant camu camu. Meanwhile, neighboring land-rich communities were very interested in working with CARE, but the NGO was not interested in working with them. As was shown earlier in this chapter, these communities were especially poor and desperate for new agricultural options. With no community uplands, they suffered greatly during flood season, making them a prime candidate for this floodplain development project. At the same time, they were skilled at cultivating native fruit trees on their limited number of precious, high restingas[26]. I was surprised when CARE personnel told me that they would not select communities based on need, and tried to avoid the neediest people.

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[24] Quechua = wood or tree trunk.

[25] One village authority listed 12 development and conservation projects in his village!

The lesson here is that these institutions preferred to plant camu camu mainly with communities that they already had been working with on other projects. It was shown throughout this chapter that when planning their work, extension agencies failed to give adequate consideration to or exploit the diverse socioeconomic and environmental situations of these communities. Now we see that levels of poverty, land availability, and access to markets were apparently also of little concern to these institutions. Perhaps like so many development institutions elsewhere, they were less interested in the welfare of their clients than their own institutional interests (see Bebbington and Thiele 1993, Fisher 1993, Meyer 1995, Loker 2000)[27].

Institutional Preferences and the Imprint of Development

Understanding processes of development means detecting and identifying the various forces which effect innovation diffusion and in the end leave a distinct imprint of development upon the landscape. The spatial arrangement of this imprint is often poorly understood, which in turn effects short and long-term regional development (Brown

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[26] Nuevo Jerusalem and Jaldar managed to cultivate fruit trees such as umarí *(Poroqueiba sericea)*, zapote (*Quararibea cordata*) and caimito (*Pouteria caimito*) as a needed food source on the very highest spots in the landscape.

[27] It must be noted that INADE was an exception to this, and often invested heavily in on-ground expenditures in the communities where they worked. They also preferred longer term projects, monitored their results, and provided quality equipment to their project members. INADE worked in just three of the 39 communities studied, and seemed to have a very limited interest in the PNCC there.

1981, 1991). This raises important questions. What in fact was the imprint of development left by the PNCC across the region? What was the nature of this imprint, and what can we learn from it?

Using Communities from Past Projects

In the case of the PNCC, the forces which effected the diffusion of this new agricultural innovation across this sample of communities were largely top-down, institutional preferences. It was not only NGOs, but state institutions which did this. The villages of Padre Bernardo and Siete de Julio provide an example of how this "imprint of development" as described by Brown (1981) was left across the region by the PNCC. The Ministry of Agriculture's Comite de Reforestación (CR) worked on the PNCC in select communities near Yarina Cocha because they had worked there before with the same farmers on previous projects. These villages were close to Pucallpa, but their floodplain lands were already under great pressure. Not only were lands limited and almost completely occupied by intensive annual cropping systems, these farmers' fields were also the sites of previous CR projects.

Figure 3-1 shows 2 clusters of camu camu fields spaced about 3 km apart adjacent to the two villages. What explains this pattern? Farmers were simply planting camu camu in the same fields where they had recently planted "capirona" trees (*Callycophyllum* sp.) with the CR for use as fuel and timber. The farmers now ended up cutting down most of the still immature capirona trees in order to make room for the camu camu. Like the capirona, the young camu camu trees were intercropped with annual crops. This pattern or imprint of development upon the landscape is thus almost identical to that of the capirona project. Without understanding the recent history of these communities, we might fail to understand this pattern.

Camu Camu Cultivation Around Wild Stands

An additional spatial pattern of this regional development program may existed, though not readily as readily apparent as the overlapping of community projects. As discussed in Chapter 2, research institutions in Peru had been studying wild camu camu for the last few decades. Because of their extensive contact with ribereños living near wild stands of camu camu, state research institutions and the Ministry of Agriculture began some of their experimental work on camu camu cultivation in these locations. These areas were home to some of the first efforts to cultivate camu camu as the PNCC began in its earliest stages. I found that extension organizations made concerted efforts to cultivate camu camu around wild stands of the fruit in the study area whenever possible, and often began their work in these locations. On the Ucayali River, IIAP did so in Jenaro Herrera and villages located near Supay-Sahua Cocha, as did CARE on the upper Tahuayo; INIA and IIAP in the lower Napo, and the Comite de Reforestación and the Ministry of Agriculture on the lower Nanay River. This gave them direct access to planting stock, and was a most convenient way to establish camu camu fields in the same environment as the wild fruit. Conversations with extensionists revealed that they felt more comfortable working in these areas, because they felt more certain of the success with planted camu camu. It was planted in the same natural environment, and the local people were familiar with the trees.

Even private camu camu entrepreneurs seemed to prefer to promote cultivation in areas near wild stands, often in remote areas, including very remote areas of the Tapiche and upper Nanay Rivers.[28] This was because they wanted to control access to wild stands, as well as any harvests (Chapter 6). This choice of location also gave them some control over planting stock, the ability to sell wild plants to others, and was a most convenient way to establish camu camu fields in the same environment as the wild fruit, essentially enriching the area with this species. This initial pattern of cultivation adjacent to the wild source resembles that of cranberry farming more than a century ago in the United States (Berlin 2002).

The Initial Imprint of Development with Camu Camu

Brown (1968, 1981) emphasizes that agricultural innovations begin in concentrated locations, or nodes, which emit messages of innovation and expand outward. Such expansion can be to the next immediate potential location (such as the nearest floodplain village, in this case), an expansion-type diffusion process. Or such diffusion can be a process of relocation, where the innovation jumps from location to location, bypassing potential adopters. These processes are often natural, long-term events, especially amongst farmers. In this case, camu camu was initially introduced into consciously selected areas that conformed to the preferences of what Brown (1981) calls the "diffusion agency", rather than concerns over poverty, access to land, or the marketing requirements of this perishable fruit. So far, the bypassing of potential adopters was due to institutional preferences, rather than a natural diffusion process.

It is far too early to know if or how the cultivation of camu camu might undergo a natural process of expansion in the region. However, the initial imprint of development from the PNCC upon the floodplain landscape of the Peruvian Amazon displays two noteworthy patterns. First, camu camu cultivation was lightly dispersed, with only limited local adoption. I found that in nine of the 31 participating villages (29%), just one or two small fields of camu camu existed. In three communities, no camu camu fields existed. Second, this adoption was widely dispersed, in communities across the region. Farmers readily trade seeds with one another, so we can probably expect the cultivation of camu camu on at least an experimental basis (such as in homegardens) to spread throughout the region to a larger number of communities. This wide dispersion of camu camu could also facilitate the expansion of its cultivation for future markets. In the case of the adoption of passion fruit in western Kenya, Brown (1981) found that the first fields were concentrated in small nodes, like we see near Yarina Cocha in Figure 3-1. Over the next decade the passion fruit fields slowly expanded out from these nodes, aided by development of the transport infrastructure. It is impossible to predict if more farmers might adopt camu camu in the future, but this new tree crop has been diffused to an extent that may aid its adoption in the future across the region. It is reasonable to expect that the larger number of camu camu fields near Jenaro Herrera and along Yarina Cocha might also facilitate the future adoption of camu camu in these local areas.

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[28] An exception to this was early efforts near the town of Requena, on the Amazon River. However, plans for a processing plant to be built in the town never materialized.

Conclusions and Recommendations

The communities in this study practiced a diverse array of income-producing activities, but they tended to rely heavily on agriculture and fishing. Communities were skilled at adapting to environmental and socioeconomic changes, but time was necessary to do so. Problems associated with agriculture have been the most difficult to adapt to in recent years. Farmers were in need of some form of agricultural support in order to expand or even maintain their agricultural activities. Cash earnings from development projects and illegal activities had recently become common and increasingly important in these communities. Within these communities, there were growing internal cash economies.

There was considerable local diversity in the environmental and socioeconomic conditions of communities participating in the PNCC. The institutions that managed the camu camu planting programs for the PNCC did not target communities with respect to these characteristics. It was therefore impossible to detect any relationship between productive activities, land use, access to resources or markets and the decision by communities to participate in the PNCC. Poverty alleviation may not have been a concern of these institutions. Most of the communities were located quite far from markets and had to transport their produce in slow riverboats.

There was a large increase in the number of development projects in these communities in recent years. Wages, aid and compensation for work on these projects promoted a competitive situation amongst institutions. This presented a problem for the PNCC because the program promised but could not provide the credit, aid or compensation necessary to sustain their projects. This dilemma appears likely to appear for future community development projects in the region, especially in agriculture. Institutions will need to assess community needs and the prospect of providing compensation before initiating development projects in the future.

Extension institutions and the PNCC itself suffered from a lack of credibility. The relatively homogenous nature of the communities' response to the PNCC (contingent upon aid or quickly abandoned) was largely due to broken promises made during the program. The communities were also hesitant to commit themselves due to problems with these same institutions in the years prior to the PNCC. However, in most communities there was no single, unified response to the initiatives proposed by the PNCC, and some camu camu was found to be growing in many communities.

Extension agencies with the PNCC arrived with a great sense of urgency. They spent much of their time trying to sell the project to communities. Coaxing and promising were necessary to start the PNCC in most communities. However, those that wanted in on the project often could not get in. There was no mechanism for farmers to experiment with camu camu cultivation in steps or phases.

The PNCC demanded rapid scaling-up and swift execution of the tree planting. The short time lines of the camu camu planting projects may have led to an incorrigible situation. Extension institutions' efforts were relatively small, but seemed to have the same problems of effectiveness and efficiency found with large institutions. Government field reports revealed that less than 10% of the camu camu originally reported to be maintained in Loreto actually existed. The ability to monitor tree-planting projects may kill the appetite of these extension institutions for these projects in the future.

In rural settings characterized by such variations of activities and local histories, one fact stands out: No community in the study rejected the PNCC or refused to participate. Despite the fact that communities wanted direct aid in exchange for their participation, the sudden demand and high prices for camu camu fruit helped stimulate local interest in planting the trees. Individual households could still make their own decisions. More research is needed to understand household adoption of camu camu farming.

The adoption of camu camu was pushed by exogenous forces of development agencies and external markets, but at the same time was influenced by local situations and ability to adapt this new agricultural innovation. This chapter has shown that attention to history is important; especially recent, local history, if development projects are to achieve their objectives. The reasons why farmers adopt agroforestry and tree planting practices must be evaluated on the basis of social and economic conditions within particular locales and at particular historical periods. These floodplain communities in the Peruvian Amazon have a history of resisting external pressures and chose to adapt to circumstances in their own, unique ways. When put in this context, we see that the camu camu planting program is also strongly affected by recent historical events in the region, such as the FONCODES program, and that any analysis of camu camu cannot escape this fact. Clearly, more research is needed to understand the complex relationships that exist in agricultural development in this region in Peru.

One issue that we cannot overlook is that these communities appear to be able to impose conditions upon development agencies. They made it clear that their adoption of camu camu was conditional. A lesson from the PNCC is that communities in this region have developed an ability to exploit the boom in rural development projects. In recent years, they have become more skilled at dealing with development agencies and responding to their initiatives. In the case of the PNCC, they found the communities ready and able to promote their own interests, and make satisfaction of demands contingent on their participation. More research is needed to understand these relationships, and the way these communities have learned to deal with the top-down nature of development projects.

It is too early to detect a significant pattern of diffusion with camu camu cultivation other than the initial imprint of the extension agencies. However, it is clear that the Programa Nacional de Camu Camu and the ribereño communities have already played an important role in converting this non-timber forest product from an extracted to a cultivated resource in Peru.

Village	Pop	Location	Dist to Mkt	CC	Specialty items
Buena Vista	37	Tahuayo	1	Yes	Crafts for lodge, camu camu
Charo Cocha	27	Tahuayo	1	Yes	Lake fish
Chino	47	Tahuayo	1	Yes	Lake fish, camu camu
Esperanza	55	Tahuayo	0.5	Yes	Avocados, fariña
Huaysi	21	Tahuayo	0.5	No	Large catfish, fish
Nuevo Horizonte	39	Tahuayo	0.5	No	Pineapples, uvillas, fruit
Nuevo Progreso	43	Amazon	0.5	No	Fariña and papayas
Nuevo Valentin	69	Tahuayo	0.5	No	Aguaje
Pihuicho Isla	33	Amazon	0.5	No	Fariña
Punga	28	Tahuayo	0.5	No	Yams and thatch
San Martin	27	Tahuayo	0.5	No	Rice
San Pedro	17	Tahuayo	1	Yes	Game meat
Santa Ana I	71	Amazon	0.5	No	Charcoal, fruit, chambira
Santa Ana II	37	Amazon	0.5	No	Charcoal, fruit, chambira
Santa Cruz	21	Tahuayo	0.5	No	Hogs, charcoal
Tapira Nueva I	9	Amazon	0.5	No	Large catfish
Tapira Nueva II	30	Amazon	0.5	No	Large catfish
Timareo I	20	Amazon	0.5	No	Vegetables
Timareo II	34	Amazon	0.5	No	Vegetables, hot peppers
Timareo III	19	Amazon	0.5	No	Vegetables
Jaldar	26	Yarapa	1.5	Yes	Bananas, fruits
Nuevo Jerusalen	18	Tahuayo	1.5	Yes	Aguaje, palm heart
El Estrecho	200	Putumayo	>5	Yes	Fish, camu camu
Marandua, Colombia	29	Putumayo	>5	Yes	Fish
Flor de Agosto	55	Putumayo	>5	Yes	Fish, game meat
Santa Mercedes	51	Putumayo	>5	Yes	Furniture, game, livestock
Villa Tinta Cocha, Colombia	6	Putumayo	>5	Yes	Camu camu, fish
Manacamiri	48	Nanay	1 hr	Yes	Fresh produce
Padre Cocha	32	Nanay	1 hr	Yes	Pottery
Moena Caño	18	Itaya	1 hr	No	Fresh produce
Jenaro Herrera	160	Ucayali	1.5	Yes	Camu camu, cheese
Nueva Pumacahua	33	Ucayali	1.5	Yes	Camu camu, cheese
Nuevo Aucayacu	30	Ucayali	2	Yes	Fowl
San Gerardo	13	Ucayali	2	Yes	Tourism and timber
Ega	33	Ucayali	2 hrs	No	Vegetables
Padre Bernardo	36	Ucayali	2 hr	No	Maize, camu camu
Pucallpillo	31	Ucayali	1 hr	No	Watermelon, vegetables
Siete de Julio	42	Ucayali	2 hr	No	Fish, fresh produce
San Juan de YC	57	Ucayali	1 hr	No	Camu camu, beans

Table 3-1. Village characteristics and specialty items for income.

Activity	First	Second	Third	Fourth
Farming	51.4	17.9	5.1	2.6
Fishing	12.8	43.6	7.7	
Wages	12.8	7.7	5.1	
Camu Camu	10.3	5.1	12.8	2.6
Extraction	5.1	5.1	17.9	7.7
Charcoal	7.7	2.6	5.1	5.1
Livestock		12.8	7.7	
Crafts	2.6	2.6	2.6	
Tourism		2.6		7.7
Payments for extraction			2.6	2.6
Timber			2.6	

Table 3-2. Sources of income for 39 villages. Order of importance in percentage.

Reasons for participating	Frequency as first answer	Frequency as second answer
Expected aid	11	11
Expected Credit	10	6
To have an additional income	3	4
NGO promises	2	2
High price of camu camu	2	1
Seeds given out	0	2
Permanent buyer/industry	0	2
The project came here	1	0
We work for their project	1	0
Extensionist convinced me	1	0
To consume	0	1
It is a government rule	0	1
Recognition by Min de Ag	0	1

Table 3.3 Reasons why villagers decided to participate in camu camu planting.

Reasons for NOT participating	Frequency as first answer	Frequency as second answer
No aid	16	12
Saw past failures of these groups	3	3
Already have wild CC	3	1
It takes too long to produce	2	2
Lack of suitable land	2	1
Too difficult to maintain as crop	2	1
Not project members	1	4
A deception by these groups	0	3
No buyer	1	0
Dislike of NGO personnel	0	1
Trees not planted in local fields	0	1
Tree dies too much in fields	1	0
Coca fields pay better	0	1
Illness	0	1

Table 3.4. Reasons why villagers decided **not** to participate in camu camu planting.

Reports	Year	No. of Families	No. of Villages	Hectares
ORMA	2000	184	22	1048.67
IIAP	2000,2001	258, NA	22	968.42 in Loreto, 5400
Ministerio de Agricultura	2000, 2002	1564, 1045	234	5,348, 5,700 total
PNCC	2002	123	37	611

Table 3-5. Figures on village participation and plantings..

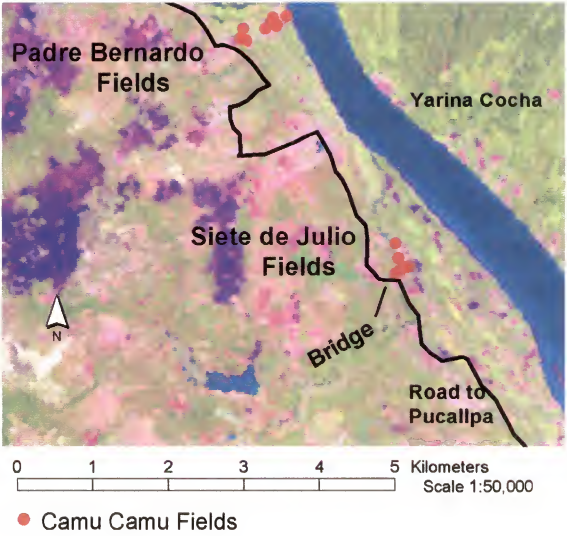

Figure 3-1. Arrangement of camu camu fields in villages near Pucallpa.

CHAPTER 4
HOUSEHOLD ADOPTION OF CAMU CAMU

Introduction

The need to understand local variations in the uneven participation of rural communities in development projects is a concern for researchers and development agencies alike (Belsky 1993, Walters et al. 1999). This includes the need to broaden and improve the research that examines elements of the decision-making process involved with the adoption of agroforestry and tree-planting projects (Scherr 1992, Murray 1996, Long and Nair 1999, Bannister and Nair 2003, Subhrendu et al. 2003). The level of local participation is considered a key element for evaluating the success for these projects, but too little has been known about household attitudes towards tree growing and why farmers grow trees for their household economies. (Scherr 1992, Mahapatra and Mitchell 2001, Bannister and Nair 2003).

In order to understand the transfer of technology and knowledge from extensionists to farmers, we must start with an analysis of the priorities and problems of farmers and farm families. Besides extensionists, farmers are increasingly recognized themselves as innovators and experimenters. Scientists have also turned to farmers to understand non-adoption of innovations, as they have repeatedly been found to be rational and right in their behavior when at first seeming to be irrational and wrong to outside observers and professionals (Chambers et al. 1989, Prain et al. 1989). A flexible extension strategy and appropriate socioeconomic environment will create opportunities for such innovations (Bunch 1989, Goldman 1993).

In Amazonia, farmers are well known for their habit of frequently experimenting with new crops, including a large number of tree crops (Smith 1996). Studies from western Amazonia have shown that household characteristics can influence agricultural change. The ability of farmers to adopt innovations in agriculture depends strongly on the nature of local conditions (Chibnik 1994, Coomes and Burt 1997, Vosti et al. 1998).

Significant heterogeneity in livelihoods exists within floodplain communities of the Peruvian Amazon. Failure to understand this diversity hinders the success of development programs in the region (Durand and McCaffrey 1999, Tagasaki et al. 2001). Among such groups of communities, this variation affects choices about participation in poverty reduction programs (Hentschel and Waters 2002). Government research institutes in Peru have reported some of the basic cultivation methods and cropping systems for camu camu used by farmers, but this is mostly economic research oriented toward promoting camu camu cultivation. Meanwhile, the overall response to the programs and incentives of the Program Nacional de Camu Camu (PNCC) was very limited (Pinedo-Vasquez and Pinedo-Panduro 2002)

How did individual household attitudes about participating in the PNCC differ from those expressed from the community level analysis in the previous chapter? Which farmers were adopting this new crop? Why were they doing this, and did their household characteristics or attitudes have anything to do with their decision to adopt camu camu? In this chapter, I examine these and several more important questions.

Methods

Approach to Research

What do ribereño farmers think about planting camu camu trees? The best way to answer this question is to draw the information from the local farmers themselves (Gladwin 1989, Bernard 1994). In this chapter, an individual extension project was selected from the PNCC in order to examine household characteristics and farmers' decisions about planting camu camu. Findings are presented from a study conducted at the household level. I start by examining the response of the ribereños, and the reasons why they decided to participate or *not* participate in the camu camu planting program. Next I analyze the data on household attributes obtained from farmers who had planted camu camu, and from those who had not adopted the new crop. Questions of farmer age and residence, land holdings and field locations, experimentation, and innovation are discussed in order to determine if these factors indicate what types of households were planting camu camu. This approach allows for a comparison of findings from the community level study of multiple projects in the previous chapter to a household level study of one specific project studied here. Attention is given to the role of a non-governmental organization in this process. Statistical analysis is provided when relevant.

Selecting a Project

To learn why some farmers might adopt camu camu and others would not do so; I chose the camu camu planting program of a single institution, the CARE-Peru project known as CASPI[1] . This NGO project was chosen because it allowed me to test assumptions and examine findings without the variations inherent in the different extension projects throughout the region. The CASPI camu camu planting project was extensive, with 258 participating families in 22 villages, or 25% of all 1039 PNCC participants in Loreto (IIAP 2000). This allowed me to obtain a sample of 62 households from 16 villages for interviews. The villages were all located within one day travel time by boat ("colectivo") to Iquitos, with market access by boat available for all. The CASPI project also worked both with families who extracted camu camu from the wild, and non-extractors. The project used the same training and visit extension method and planting script as the PNCC employed.

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[1] "Caspi" is a local term referring to the trunk of a tree, said to be Quechua in origin. The CASPI project was a CARE agroforestry project for 400 families in the study area before it joined the PNCC.

Conducting Interviews

I used a semi-structured questionnaire (Appendix B) for interviews with individual farming families to obtain their household and land use characteristics. Appendix B illustrates the range of questions to select from that could be asked of the most stubborn informants in order to understand their decisions and motivations for their actions. Long conversations also provided many answers, especially concerning sensitive questions and topics. In most households, both the male and female heads were present and participated in the interviews.

The questioning method resembled that used by Gladwin (1989) for studying rural farmers' land use decisions about their adoption or *non-adoption* of extension recommendations. Questions were asked not only to elicit responses, but also to provide any sequence of decisions the people made with regards to camu camu. There was no significant sequence or pattern to their decisions regarding the adoption of the new crop, but conducting the interviews in this fashion proved to be effective for obtaining information about their specific decisions, motivations, and attitudes.

With farmers who said they had planted camu camu, we also went into their fields to verify this discussed their farming practices. Some of these fields contained camu camu. Most did not. In this environment, the goal was to learn more about household landholdings and land use practice and try to stimulate conversation about their agricultural practices and needs by actually being in their fields. This method often involved working with the ribereños (e.g., picking camu camu, weeding their gardens).

Applying methodology

The CASPI project served 22 villages located along a continuous stretch of the Amazon basin in the Tahuayo river and Muyuy Islands (Figure 1-5). Sixteen of these villages were visited (73%), by drawing their names from a hat. A total of 78 households were randomly selected by making circles or repeated passes in villages. Households were slow to receive me; repeat visits were necessary in almost all cases.

Cooperation levels and the demeanor of residents varied. Sixteen households refused to answer questions or participate in the study. These were almost always non-adopters, so there is some bias towards selecting adopter households. It became clear that for every adopter found in a village, at least eight to ten households were probably not adopting the new crop. The goal of these repeated visits to multiple communities was not only to produce a representative sample of both adopters and non-adopters, but the gain an improved understanding of their livelihoods, household attributes, and decision-making.

Results

The reasons given by 62 households for the decisions they made are illustrated in Tables 4-1, 4-2, 4-3 and 4-4. Fifty-six of the 62 household heads (90%) were males. Household heads were asked to give the two most important reasons for their decision to plant or not plant camu camu, but some only gave one reason. There were two types of households – 27 camu camu adopters (44%), and 35 non-adopters (56%). Within these two groups there were two noticeable subgroups: 1. casual adopters, and 2. opportunistic participants (i.e., non-adopters).

Casual adopters (five households) were those who had planted camu camu as a small experiment, and were cultivating from 25 to 50 trees, rather than several hundred or over 1000 trees as adopters were cultivating. Field inspections to all gardens revealed that this effort was small, but indeed an adoption of *M. dubia*, as the trees were being managed with care and to produce fruit. Opportunistic planters (16 households) were those who had made a minimal effort to plant or *appear* to cultivate camu camu in order to formally join the program, and then quickly abandoned the effort. Only four of these opportunists even had living trees to show me. These were just a few scraggly, struggling plants smothered in weeds. Note that in Table 4-3, the opportunistic participants gave their reasons for deciding to plant camu camu, and for *giving up*. Most admitted they had made a poor effort to begin with.

Decision-making: Discussion

Opportunism and the Decisions of Farmers

Chapter 3 shows how communities had decided to participate in the PNCC mainly because they were expecting economic aid or credit promised by the different projects. At the household level in the CASPI project, over half the households (52%) were motivated for the same reasons to plant camu camu (Tables 4-1 and 4-2). However, this was not in any way the most important reason for the farmers who had actually adopted camu camu. The desire for additional income was their primary reason (Table 4-1). Nor was it for the non-adopters farmers that had *never* planted camu camu. Less than one-third of them reported that a lack of aid or credit was the reason for this decision (Table 4-4). It was clearly the opportunistic planters that wanted aid or credit. Thirteen of the 16 opportunists (81%) reported this as the reason for their decision to plant camu camu, and two others said they planted because of CASPI promises of other types of support. Four of the opportunists also reported that they had initially planted camu camu because of additional promises of aid made by industry representatives who visited their communities and encouraged them to work with CASPI (Table 4-3).

These findings help explain *why* this sub-group of non-adopters were opportunists; they wanted aid or credit in return for any effort they made, and quickly grew fed up when it failed to materialize. Another opportunist had simply been obligated to plant camu camu because he had stolen materials from the project, and CASPI made this his pay back for the crime. The interviews revealed that camu camu cultivation was usually not considered too much work by these opportunists; it was just that the expected aid never came for them, and they abandoned the effort. Only one opportunist reported that income from fruit was what initially motivated him to plant the crop.

Three of these opportunists were the village leaders for the CASPI project; not a surprising fact given the overwhelming reason for the motivation of this group. Most of these opportunists told me that their seedlings had been so poorly planted that they never would have produced or even survived if they had tried to maintain them. Theirs was a simply a minimal effort to obtain aid from CASPI or the PNCC. This situation might appear to support the view of Pinedo-Vasquez and Pinedo-Panduro (2002) that most ribereños perceived these programs as little more than short-term financial opportunities.

However, the results of the interviews show that many ribereños planted camu camu because they saw it as an income-producing alternative, contradicting this view. The high price of camu camu fruit and the new industrial market were also important reasons for their decision to adopt the new tree crop (Table 4-1). Moreover, the findings demonstrate that most of the non-adopters who never planted camu camu in the first place were not concerned with financial aid. Through the household interviews, we learn that the opportunistic participants constituted a distinct group in the PNCC that should not be confused with all non-adopters.

We should not be overly critical of these often vociferous and angry opportunistic participants because they had from the beginning been repeatedly promised financial assistance, and expected it. CARE was well-known for making promises to boost participation and compliance in its many projects, and its CASPI project was no exception. The ribereños were also angry that they had been criticized by CASPI and PNCC promoters, as if they were to blame for not living up to their end of the deal. Planting camu camu is a land use decision where the harvest is an undetermined and long-term benefit. There was still no established custom or routine for cultivating the fruit tree. Lack of credit has been a major constraint to adoption of agroforestry systems in Amazonia (Smith 1996, Smith et al. 1998, Vosti et al. 1998), and it was shown in the previous chapter that there was a legitimate need for some form of monetary assistance with agriculture in these floodplain communities.

Household Experiences with CASPI: Perceptions and Patterns

The interview process revealed both the experiences of the people with the CASPI project as well as the motivations for their actions. Most of the camu camu adopters said they were motivated by the potential income they could obtain from the fruit, and the prospects of a new industry. Non-adopters gave the most diverse set of reasons for their decision(s), but fell into two basic categories: 1. Opportunistic participants who had initially planted camu camu and then abandoned their efforts because promised aid never came, and 2: The non-adopters who had never planted camu camu but had problems with the CASPI project itself, not just with undelivered aid. They felt excluded and were critical of the project, and were concerned about past failures with other CARE and CASPI projects in their villages.

These findings reveal how three groups of people, each with distinct views about project stand out. One view focuses on the merits of the new crop itself (income potential), while the other two address institutional problems (deception and alienation). The use of a group format by CARE with their projects since their arrival in the area may help explain this variation in attitudes. A group format provides an efficient way for extensionists to work, but there are many disadvantages to working with groups of farmers. One of these is a tendency for original members of the group to adopt attitudes over time that make it difficult for new farmers to enter the group (Chambers et al. 1989). I was told that this problem was prevalent in that the original CASPI members frequently balked at allowing new members to join, because they did not want to divide any aid that might come from the project among a larger group. Indeed, CARE was known for rewarding their core groups of participants after finishing projects.

The concern by non-adopters over early failures of the previous CARE projects in their villages was certainly understandable. Credibility is frequently lacking in agricultural extension service (Bunch 1989), and findings reveal that such a problem existed with CARE and its CASPI projects in these communities even before the PNCC. This is one reason why CARE brought camu camu promoters from the government and industry to the communities, but residents were leery of this tactic. The success of extension activities also depends on the relationship between extension agents and farmers (Rivera and Zijp 2002). Frequent charges of abuse and favoritism were leveled against CASPI, even by the camu camu adopters. For example, in every village I visited, residents told me that the CASPI list of participants was filled with names of people who were never part of the project [2]. Another complaint was that participants had to sign documents saying they had received or were to receive material aid that was never delivered. These two practices are common with development projects in this area of Peru, and the local people are well aware of it. There were also complaints about womanizing and unpaid bills at village stores. These latter problems are all too frequent as an increasing number of development projects reach rural communities.

It is not fair to blame CASPI as responsible for the basic shortcomings of the PNCC itself, including the recent problems with marketing of the fruit. Virtually all rural development projects are problem-ridden (Walters et al. 1999). However, local anger over the behavior of CASPI personnel caused feelings to boil over into widespread denunciations. We must not forget that at the same time, FONCODES was paying the ribereños to build coveted infrastructure in their communities. Through careful examination of interview data, we are able to see the emergence of distinct attitudes about camu camu planting between groups of households. This finding raises the question of how such variation might be further explained.

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[2] I was given lists of PNCC participants by four government agencies: Ministry of Agriculture, INIA, IIAP, and ORMA. The list often had names of every adult in the household as separate participants, each with a camu camu field, including elders.

Household Income and Camu Camu Adoption

Access to Wild Camu Camu

It is logical to assume that households with access to wild camu camu would be less likely to plant camu camu than those who had no access to camu camu. Twenty-one of the 62 households interviewed (34%) had access to wild camu camu and sold the fruit, while 41 had no access (66%). Nine of 27 camu camu adopters had access to wild fruits (33%), while 12 of the 35 non-adopters (34%) had access to wild camu camu harvests. The small sample size restricts the ability to arrive at conclusions, but in this case the findings suggest that families who have no source of wild camu camu were no more likely to cultivate camu camu than those who already had an accessible and marketable source of wild fruit. Furthermore, of the 21 households with access, nine were adopters (43%), while 18 of 41 households that had no access (44%) were adopters, nearly the same portion. In some cases, access to the fruit may have helped motivate families to plant camu camu. For example, four of the households with access said they decided to plant camu camu because of concerns over local competition for the wild fruit.

Analysis of the decision-making criteria for households reveals that the nine adopters with access to wild harvest based their decision to cultivate camu camu strongly on income potential (six responses) and a desire to have their own camu camu (two responses). This makes sense, as the families harvesting the fruit from the wild already knew of the income they could receive from camu camu, and were concerned about competition for these harvests from other villages. The 18 camu camu adopters without access to wild fruit were indeed influenced by the income potential and high price of the fruit (12 responses), but were much more influenced in their decision by ideas and promises from CASPI (seven responses).

Household Occupations

The main source of income for roughly half of these households was farming (51%), 23% reported it to be fishing, 10% were charcoal producers, 5% earned money from development projects, and the rest (11%) practiced a mix of activities (Figure 4-1). However, the main source of income reported by the adopters was highly concentrated in two activities; either farming or fishing for 90% of these households. Non-adopters reported more diverse sources of income than adopters, with farming or fishing as the main source of income for 63% of this group (Figure 4-2). Might adopters be involved in farming more than non-adopters? Indeed, 63% of the adopter households said that farming was their main source of income, compared to 43% of non-adopters.

This may help explain *less* participation by this group, but it does not provide convincing evidence for the non-adoption of the new tree crop. In fact, nine of the fifteen non-adopters (60%) who were farming households reported that tree crops were an important part of their income, compared to just 35% of the adopters who were farmers This suggests that these adopter families were perhaps more anxious to adopt a tree crop for added income, because almost two-thirds of them lacked such an income source. Their own responses to the interviews support this theory, as the majority said they planted camu camu for the additional income.

Non-farm Income

Non-adopter households reported a greater number primary income sources than adopters, including non-farm sources (Figure 4-2). This is important, as all of the households surveyed practiced some agriculture, but for 20 of the 35 non-adopter households (57%) their primary income earning activity was not farming. This gives credence to the claim of many non-adopters (34%) that they were often too busy with other work to have the time for cultivating camu camu. As a whole, this group had less interest in farming to begin with. Six of the 35 non-adopters (17%) said that charcoal-making was their main source of income, compared to none of the camu camu adopters. Charcoal-making has become increasingly popular in the household survey area because it is a form of quick, secure income for people. Eighteen of the families surveyed (29%) reported that they made charcoal, but field observations led me to believe that more were involved in this activity. Charcoal-making for commercial purposes is illegal, and it was probably underreported as an economic activity by the people in this survey. It was an important activity in many other villages also located within a days travel time of Iquitos (Chapter 3).

While an equal number of opportunists and non-adopters reported charcoal as their primary income source, it was the non-adopters who had never planted camu camu who said they were too busy with other work All but one of the household heads surveyed that worked in projects, for other wages, trade, or owned stores ("bodegas") also came from this group. This shows that the 19 families that never planted camu camu were indeed busy with many occupations, while the opportunists were occupied with fewer tasks, and willing to at least try planting camu camu with the hopes of receiving aid. Thus, a breakdown of the different sources of income for families also shows distinct differences between these two groups of non-adopters. As with the decision-making analysis, it also reveals the opportunistic nature of a distinct group of families.

The Need for Quick and Secure Income

Ribereños across the region have increasing needs for cash, even for daily life within their communities (Chapter 3). Quick money was also made in the CASPI project area through other extractive, illegal activities such as hunting "majas" (*Agouti paca*), and fishing with poisons. Indeed, these people (especially younger people) said they preferred to earn income from almost any source other than agriculture, because of the risks involved, and time of effort required to earn money. Wages earned from development projects, or agricultural labor might be low, but were popular sources of quick income, especially with young adults. Many non-adopters told me that they wanted credit not to apply to agriculture, but for off-farm investments such as fish nets, chains saws, and boat motors[3]. When I asked how they would pay off loans if they ever received them, they told me charcoal making was the best way, perhaps the only secure way to pay back loans and other debts.

Vosti et al. (1998) stress that as families diversify income through off-farm sources, this search for alternatives may open a window of opportunity for the adoption of agroforestry systems. In the case of camu camu adoption, we see that off-farm income was increasingly important in this area, and that farmers who did not cultivate fruit trees tended to be the adopters of camu camu. However, these adopters were already the most dependent on farming. Non-adopters were most dependent on non-farm income and had increasingly less interest in farming, whether with traditional crops or the new agroforestry systems with camu camu. Indeed, the feeling that agriculture was no longer worth the effort to earn a living was pervasive at the time of this study.

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[3] During the last period of extensive credit for agriculture in the late 1980s, most people said they had also invested their loans in off-farm uses. They also said that very few people had ever repaid these loans.

Agriculture, I was told, was simply less attractive than ever as a source of cash for these traditionally farming families. While this reminds us of the very risky nature of floodplain farming in Peru as emphasized by Chibnik (1994), it is not as if farmers were shifting their cropping to non-flooding environments. Instead, there appears to be a trend to move away from agriculture as a primary source of household income. This situation again supports the argument of Smith et al. (1998) and Vosti et al. (1998) about the vital need for credit to assist the adoption by farmers of innovations in agroforestry. Non-farm income is increasingly viewed as the best way for ribereños to earn cash in this rural area of Peru.

Besides this agronomic dilemma, there are no doubt other important factors related to the varying levels of local participation in the CASPI project. So far, findings here have shown how patterns of household livelihood reveal important processes at work in ribereños decisions concerning the adoption of camu camu. This makes it necessary to examine some of the internal characteristics of these households.

Household Attributes and the Adoption of Camu Camu

Age

In a broad-based survey in Haiti, Bannister and Nair (2003) found that older farmers were more likely to adopt innovations with tree culture than younger farmers. Ranging in age from 23 to 76 years, a typical farmer was 47 years old (median; mean 46.3, SD 12.566). There was no significant difference in the mean ages of the two groups of farmers. A typical adopter was 47 years old (median; mean 48.2, SD 13.06) compared to 46 (median; mean 44.7, SD 12.14) for non-adopters. The relatively high mean age for household heads can in part be explained by out-migration to Iquitos.

Ribereños in four villages had mentioned that they had not participated in camu camu planting because the tree takes to long to produce (see Chapter 3). Younger farmers may be more likely to experiment with alternatives whose benefits will be available only after several years. However in this case, findings do not suggest that age was a factor in farmers' decisions to plant camu camu. Rather than absolute age, a person's physical condition and their family relations which change over time probably influence decisions for adopting new crops. Illness, for example, was reported in Chapter 3 to be reason for limiting village participation in the PNCC.

Still, there is reason to believe that age may help explain people's attitudes about agriculture. As mentioned, younger ribereños seems less interested in agriculture. Five of the 19 non-adopters who never planted camu camu were under 30, while none of the opportunistic planters, who at least became involved in the PNCC, were under thirty. Just three of these sixteen opportunists were age 35 or under, compared to seven of the nineteen non-participants (37%). At the same time, only one camu camu adopter was under 30, and only two adopters were under 35. This suggests that age cannot be dismissed as a factor that may influence participation in the PNCC. If anything, the findings here indicate that *older* ribereños have more interest in agricultural innovations. In a large survey of households in Haiti, Bannister and Nair (2003) found that it was older farmers that tended adopt new techniques of tree culture. It may be that as farmers grow older, they appreciate the value of agricultural innovation. The lack of a significant difference in age between adopters and non-adopters is also partly due here to the fact that farmers in the sample were relatively old to begin with.

Residency

Coomes and Burt (1997, 2001) have shown that in the study area, the number of years that families have resided in a community can have a significant influence on their land use strategies. In the CASPI project area, a typical household head had lived 37 years in their community (median; mean 37.06, SD 17.306). However, there was no significant difference in the two groups between the numbers of years they had spent living in their communities (Table 4-5). As with farmer age, there was little variation between the two groups. There were few newcomers to the CASPI project area. The mean time of residency is impressive, especially considering the reputed rural mobility of ribereño households in this area as reported by Newing and Bodmer (2003). However, most of these households had members who were alternating their residency between Iquitos and their communities.

Family Size

Many rural families follow the strategy of a large family, because children can provide an important source of labor (Chambers 1983, Netting 1993), and agriculture in the region is a non-mechanized, very labor-intensive activity where maintenance activities are staggered to accommodate labor availability (Hiraoka 1986, Padoch and de Jong 1987, Chibnik 1994). Findings thus far indicate that with camu camu, labor might a major constraint to adopting the new crop. For example, we learned in Chapter 3 that farmers in four communities reported that they had not planted camu camu specifically because of the difficulty in maintaining it, while farmers in three-quarters of all communities had reported that they needed aid or credit to adopt camu camu, primarily to hire laborers for weeding work. With the CASPI project, more than one-third of the ribereños who decided to plant camu camu (37%) quickly abandoned the effort (Table 4-3). Over half of the non-adopters also wanted aid or credit to farm camu camu (54%), while twenty percent of them reported that adopting camu camu was too much work for them (Table 4-2).

It could be expected that the largest families have greater ability to farm lands and adopt a tree crop such as camu camu. This makes it important to test if there were more children living in households of camu camu adopters. A typical household had 3 children (median; mean 3.2, SD 2.17). Here again, there was little variation between the two groups, and there was no significant difference in children per household (Table 4-6). The household size is comparable to other studies of small farmers in western Amazonia such as Vosti et al. (1998), and reflects the out-migration of children to Iquitos.

Simply counting the number of children does not indicate their ages, health, or working ability. As infants and young children may fail to provide a net labor benefit to households, the number of children aged ten or over in each household is a better gauge, because they are better able to perform heavy agricultural labor[4]. In one-third of adopter households there were no children aged ten or older. For non-adopters, only 22.9% were without these older children. Still, there was no significant difference in the number of older children between the two groups (Table 4-7).

Despite these findings, their parents felt that older children who lived in the household were a valuable asset to household agricultural strategies[5].Nevertheless, no correlation was found between the number of older children and the number of chacras worked by either camu camu adopters or non-adopters, whether in floodplains[6] or uplands[7]. A test to determine if families with more of these older children were working more land is also appropriate. Again, there was no correlation found between the number of older children and the number of hectares (field area) worked by either camu camu adopters or non-adopters, whether in floodplains[8] or uplands[9].

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[4] The people say that by the age of ten, kids begin to have the strength and endurance of an adult.

[5] Many older children leave their families to go to one of the three secondary schools in the household study area.

If camu camu is demanding work as many locals reported, and older children are so important to the household labor pool, what explains the lack of significant differences and relationships in these household attributes, especially between adopters and non-adopters? Turrell and McGuffog (1997) stress that our understanding of farmer adoption of agricultural innovations is often likely to come less from quantitative analysis than from insights gained from a qualitative-exploratory perspective. My observations and experiences in the region lead me to believe that *quality*, rather than quantity of field hands is important within farming families. If a child is healthy and avoids major illness or injury, by the age of ten they are participating in the heaviest and most time consuming labor of their gender. They are especially valuable to unstable or dysfunctional households. For example, alcoholism and broken marriages were often observed in the study area. This obligates children to assume adult roles in households.

Injuries or illnesses to parents can also force children to replace their labor for long periods. One village reported that illness was an impediment to their participation in the PNCC (Chapter 3). Deaths from accidents, childbirth, and disease can hurt a family's ability to farm, but the long-term effects of sickness and poor health probably have a stronger impact. For example, malaria had stricken several villages in the CASPI project area in recent years. Several ribereños died, but it also left more than 100 adults weak and unhealthy, which seriously impedes their ability to do hard labor.

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[6] r = .018, r = .058 for adopters, r = -.010 for non-adopters.

[7] r = .102, r = .135 for adopters, r = .035 for non-adopters.

[8] r = .148, r = .156 for adopters, r = .096 for non-adopters.

[9] r = .098, r = 172 for adopters, r = .031 for non-adopters.

The capability of a household to work and cooperate as a unit, and with other families, is probably at least as important as the sheer number of family members. Walters et al. (1999) found this to be true with rural development projects in the Philippines. Many adopter households were said to be more stable and functional than those of non-adopters. This also applied to entire communities[10]. The ability to host successful "mingas" with community members (work parties that assist the host family in exchange for food and reciprocal cooperation) is another important factor.

Land Holdings and Camu Camu Planting

Coomes and Burt (1997) have shown that in the CASPI project area, households that possess more lands are more able to adopt agroforestry systems and experiment with different land use options than less land-rich households. The issue of land availability is therefore important when considering the adoption of camu camu in this area.

When asked if there was plenty of floodplain land to farm, 30 of the 62 households (48%) reported that these lands were limited in some way. The other households (both adopters and non-adopters) reported that there was plenty of floodplain land to farm as they wished. These farmers noted that there were some problems with sediment deposits or excessive flooding of these lands. They also acknowledged that in some communities floodplain lands were less available than in the past, and non-timber forest resources were less abundant on the floodplain than before. However, farmers insisted that there was plenty of floodplain land for traditional agriculture as well as camu camu, even on island communities. Their view was that people concerned over the amount of land were simply complaining, and unwilling to work hard.

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[10] The village of Punga was the self-proclaimed "drunkest village of the Tahuayo", with only one adopter. Chino and Esperanza were also notorious for their drinking, and had very few adopters.

Just one community (Huaysi) was in complete agreement that their floodplain lands were limited to the extent that they were restricted in their agricultural options. The reason for this was that new villages had surrounded Huaysi, denying them access to non-flooded uplands, and concentrating their land holdings into a relatively small area on the Tahuayo floodplain. Surprisingly, this community had as much participation, if not more than other communities in the CASPI project.

Seven of the 35 non-adopters (20%) reported that they had not planted camu camu because of a lack of floodplain land suitable for the crop (Table 4-2). This meant either lands that had problems with heavy sediment deposits which would smother the crop (four responses), or their lands were high restingas. These high restingas rarely flooded, were not recommended for camu camu cultivation by CASPI, and were already managed for other commercial tree crops. Households were typically cultivating four fields (median; mean 4.24, SD 2.09), with three floodplain fields (median; mean 2.94, SD 1.74) and one field in uplands (median; mean 1.31, SD 1.53). There was no significant difference in the number of fields reported between adopters and non-adopters, so it was not as if non-adopters were tending to more fields and therefore had less time to dedicate to a camu camu field (Table 4-8).

When we look at the area under cultivation, households were typically cultivating 2.75 ha (median; mean 3.23, SD 2.18), with 1.5 ha in floodplain fields (median; mean 1.86, SD 1.21) and one hectare in uplands (median; mean 1.37, SD 1.86) (Table 4-9).

There was no significant difference in the number of fields cultivated in either environment by between adopters and non-adopters (Tables 4-10, 4-11). However, camu camu adopters cultivated a significantly greater area of floodplain land than non-adopters (mean 2.22 ha vs. 1.58, SD .99 vs. 1.29) ($t= 2.768$, df 60, $p< .01$) (Tables 4-12, 4-13). Having more floodplain land under cultivation obviously gave the adopters a greater degree of flexibility when deciding to dedicate a portion of these lands to camu camu cultivation Adopters intercropped camu camu with annuals exclusively in floodplain fields; no upland fields contained camu camu. These findings also concur with what Coomes and Burt (1997) had concluded about the importance of land assets to farmers' ability to practice agroforestry in this same area.

The reason I decided to ask specifically about land being worked was that it is impossible to verify if the lands households claimed to own was in fact in their control.[11] When visiting their lands, the farmers and I often came across chacras that had been made from their lands without their knowledge. It was difficult enough for many farmers to estimate the area of land they said they cultivated, and even harder to do so for old fallows or forests. In this study it was more important to determine how much land households actually cultivated in order to compare the level of land use between the two groups of farmers. This not only provides a perspective on the relative effort that the two groups of households put into farming, it helps explain why non-adopters might view the adoption of camu camu as a more formidable commitment than adopters.

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[11] Many farmers boasted they held hundreds of hectares, when other community members informed that this was not true, and of their propensity to brag, and try to claim ownership of the community. Land titles for floodplain lands were very rare, lands claims were rarely sold, and land "holdings" in reality change with time.

Distance From Homes to Fields

The ribereños in the CASPI project reported that distance influences their decision to farm lands. Several farmers told me that they had abandoned efforts to cultivate their most distant upland fields because of the time involved in reaching these spots, difficulty in transporting harvests, and theft. This situation calls for a look at the issue of distance from farmer homes to their camu camu fields on the floodplain.

Distance was measured in the amount of time (minutes) it takes to reach a field, on foot or by canoe, or a combination of both. Ranging in travel time from 1 to 40 minutes, a typical camu camu field was located 10 minutes from the home (median; mean 11.1, SD 10.664). Nearly half of the fields (49%) were located five minutes or less from the home. Around one-quarter of the fields (26%) were located within a minute or less from the home; adjacent to or merging with home gardens.

There was no significant difference in the mean distances from homes to floodplain fields between adopters and non-adopters. However, the camu camu fields of adopters were significantly closer to farmers' homes than were those of the opportunistic planters ($t = 2.852$, $df = 41$, $p < .01$). Might this help explain why these opportunist farmers abandoned their camu camu fields? The differences found in the mean distances may at first appear striking (7.8 min vs. 16.7 min), with opportunistic planters' fields more than twice as far as adopters' fields. The opportunists' fields were even twice as far on average as the closest floodplain fields to the homes of non-adopters.[12] However, these absolute numbers probably mean little to people who are accustomed to walking and paddling long distances. Moreover, both figures represent fields that were considered close to home in absolute distance.

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[12] Of the19 households interviewed that had never planted camu camu, 18 (95%) had floodplain fields. Their closest floodplain fields were significantly closer (mean of 8.3 min vs. 16.7 min) than the camu camu fields reported by the opportunistic planters ($t = 2.097$, $df =32$, $p < .05$).

Crop theft was a problem in this area. Farmers reported that having chacras within sight or earshot of the home was the best way to avoid theft of high value crops. Many of these crops (such as vegetables) were interplanted with camu camu. Only two opportunistic planters had fields within sight of their houses, compared to nine adopters. But theft was less of a potential problem to the opportunists, as six of them (38%) had planted their camu camu without any other crops, a rare form of adoption practiced by only one of the 27 adopters. With no need to weed annuals, these opportunists may have had less concern about the condition of the fields where camu camu was planted.

Field Conditions and Distance to Homes

Might maintenance such as weeding diminish as the distance from home to fields increases? If so, this could provide support to the hypothesis that the significantly greater mean distance from home to field of the opportunists was indeed a factor (non-cognizant) in their decision to abandon their camu camu. Remember that one-fifth of the non-adopters reported that cultivating camu camu was too much work, as did three of the opportunistic planters (19%). Overall, data show that the fields surveyed from projects elsewhere in the PNCC were better maintained than CASPI fields (see Chapter 5). However, there was no correlation between field conditions of the forty-six CASPI fields surveyed and the distance of these fields from farmer homes ($r = .175$). An analysis of the sample of forty-three camu camu fields from multiple projects also failed to show a correlation ($r = .077$). Despite the significant difference found in the mean distance to camu camu fields between adopters and opportunists, distance itself does not seem to be a factor in what caused these opportunists to abandon their fields. Nor does it explain the relatively poor condition of adopter fields in the CASPI project.

Measuring the Impact of the CASPI Project

The results of extension projects on land use have been mixed (Scherr 1992). In the previous chapter, we learned that the most recent government surveys found that just 8.7% of the camu camu originally reported by extension agencies to be growing was still maintained in fields by 2002 (Ministerio de Agricultura 2000, PNCC 2002). The CASPI participants were found to have sources of income and land use practices similar to most other PNCC participants living across the floodplain environments of the region. With these basic similarities, it is useful to compare the level of participation in the CASPI project to the participation in the entire PNCC.

CASPI documented that a total of 258 families were cultivating 174.98 hectares of camu camu (an average of .68 ha per family) in 22 villages by 1999. Ninety-five families from seven villages had planted 65.78 hectares in the Amazon project area, while 163 families from 15 villages had planted 109.2 hectares in the Tahuayo project area (IIAP 2000). Findings from the fields surveyed during the household level analysis suggest the numbers of families that had actually adopted the new crop or even planted camu camu was far less than these figures. I verified through field inspections that 31 families in 14 villages were cultivating 20.51 ha of camu camu from the CASPI project. This was 12% of the families and 11.7% of the total field area reported by CASPI. Still, this level of adoption is higher than the overall adoption level of 8.7% reported by the PNCC. From interviews and field surveys, I estimate that this probably represented about three-quarters of all existing camu camu fields from the CASPI project. If we add 25% to each of these figures, this would be roughly equal to 39 families cultivating 26 ha of camu camu.

One section of the PNCC (2002) report gave figures for the CASPI project in the Tahuayo River. Nine families were listed, cultivating a total area of 6.5 ha, or an average of .72 ha per family. Data from this dissertation verifies that at least 18 families were cultivating 12.51 ha of camu camu (an average of .7 ha per family), double the level of adoption reported by the PNCC. Such discrepancies in figures points to the need to view the PNCC figures with caution, and questions their validity. This also suggests that the CASPI project may have had more impact than previously thought. Many of these fields had recently begun to produce fruits, encouraging their continued maintenance. More research is needed to see whether these farmers will continue to maintain and benefit from this camu camu.

Local Diffusion of Camu Camu Planting

Small-farmer spread of technologies is significant, and there is considerable evidence of the spread of program-induced technologies beyond where they were introduced and after the programs have left (Bunch 1989). The CASPI project left in late 2000. This exit does not in any way stop farmer interactions, nor their memories and observations of the camu camu planting project. With their tradition of exchanging planting stock and agricultural experimentation, it was logical to assume that some of the ribereños might be experimenting with camu camu on their own.

A survey of the household study area was made to check for independent experimentation with camu camu. The search found at least 19 non-CASPI camu camu fields, mostly in the upper Tahuayo River area. Five fields were in a community that had not participated in the CASPI project. Fourteen of these 19 fields (74%) had been started with at least some wild plants pulled up from the riversides. This makes sense, as wild camu camu is abundant on the upper Tahuayo. Three of the fields were established during the period of the CASPI project, but their owners insisted they had no involvement with the NGO. Two fields were started *before* the arrival of the project or export industry, and 11 fields after CASPI had left. One field was a school project that hoped to raise money through the eventual sale of fruits, another was a local men's club. What is clear from this finding is that there was still local interest in cultivating camu camu outside of a formal development project.

These 19 non-CASPI fields were very small in size, often tiny patches. Half the camu camu patches were less than .25 ha in size. Only the two club projects were more than .5 ha in size. Here we see an informal, low-risk, and more natural process of farmer experimentation with camu camu. These efforts resemble the step-wise experimentation that most small farmers need to practice (Chambers et al. 1989, Prain et al. 1999), and the custom of experimenting in home gardens which is common in Amazonia (Smith 1996). Most of these households involved were active members in village organizations, but did not wish to take the time and risk involved with dedicating an entire field to camu camu, as required by the CASPI project. Notably, all but one of these households had access to wild camu camu, which made it much easier for them to choose this route of experimentation compared to the adopters from the CASPI project[13].

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[13] The five casual adopters from the CASPI project probably fall into this class of step-wise experimenters, although they were under persistent pressure to enlarge their plantings to comply with the rest of the participants.

Local Innovators and Experimenters

Chibnik (1994) has noted a lack of experimentation by floodplain farmers in the Peruvian Amazon. This may be true for some farmers, but it was certainly not the case with camu camu. Most of the farmers that had adopted camu camu exhibited exceptional ability and took pleasure in experimenting with the new crop. They also experimented with more than 50 other crops, including spontaneous species in their floodplain fields (see Chapter 5). During my study, farmers frequently asked me to bring them planting stock from other areas. This habit of experimenting did not just apply to agriculture. In most adopters I noticed skills and interests that were especially broad, diverse, potent, and strong. The same was usually true for their spouse. They owned many pets from the wild, and often played musical instruments. They also raised wild birds, snails, bees and paca as experiments. This desire spread to their fields. This observation is not meant to dismiss the plethora of human skills and unique practices I found throughout the region, but this applies to agriculture. These experimenters were often quite old, and had little or no family help. Most of them told me that they worked well as a team with their spouses. Throughout the region, camu camu adopters exhibited these traits – experimentation and innovation, a love of the land and natural resources, regardless of age. Some proudly called themselves "amantes de plantas" or "amantes de la tierra" (lovers of plants, of the soil). Their houses were often located away from villages. Learning from these experimenters was the most enjoyable part of this study.

As previously mentioned, ribereños were still cultivating camu camu after the CASPI project left and in villages that had never participated in the project. Two families had planted camu camu and successfully managed the trees for fruit several years before the arrival of the export industry and the NGO. Moreover, farmers were cultivating camu camu in association with a wide variety of crops, including tree crops, in much more diverse ways than promoted by the PNCC planting scripts. The adoption of camu camu was in fact a large, risky experiment for these farmers.

Many of these experimenters whether in the CASPI project or not, told me they would increase their plantings of the tree depending on its performance. Others explained that they were already satisfied, and were simply waiting until markets became more secure before they would plant more. Such strategies support the argument of Chambers et al. (1989) and Prain et. al (1999) that a process of step-wise adoption of new crops is the preferred and logical way for most small farmers. This provides an important lesson for future development projects that might seek to compromise farmers in the same way as the PNCC.

Conclusion

Households with no access to wild camu camu were no more likely to adopt the cultivation of camu camu with the CASPI project than those with access to the resource. Adopter households were more dependent on agriculture for income than non-adopter households. Just over half of the households sampled in the CASPI project said they decided to plant camu camu because of expected aid or credit. However, most of these financial aid seekers were opportunistic participants who quickly abandoned their effort to cultivate camu camu. The main reason farmers actually adopted camu camu was to earn additional income.

As farmers diversified their sources of income, some viewed intercropping camu camu planting annuals on the floodplain as a viable new way to do this, while most found non-farm income to a better alternative. Adopter households were especially dependent on farming as a source of income, and farmed a significantly greater area of floodplain land than non-adopters. Non-adopters were less engaged in agriculture than other residents. Non-adopters had more diverse sources of income than adopters, and preferred quick sources of cash from non-farm activities. Charcoal-making had become an increasingly important source of income for non-adopters.

When examining the PNCC at the household level, we are able to see the presence of distinct attitudes and practices between groups of households. Among the non-adopters, a unique sub-group of opportunistic participants was identified. These opportunistic participants had initially planted camu camu in order to obtain financial aid, but quickly abandoned the effort. Among the camu camu adopters, a sub-group cultivated very small plots of the trees in an experimental rather than commercial effort.

Non-adopters who never planted camu camu were not concerned with the offers by CASPI or industry of financial aid as an incentive to plant camu camu, and had more diverse sources of income than the other groups. On the other hand, this was the primary concern of the opportunistic planters, and their actions were contingent upon the arrival of aid.

Adopter families, with more floodplain lands in crops, were more anxious to adopt a tree crop for added income, because almost two-thirds of them lacked commercial tree crops in their fields.

Households were turning to non-farm sources of income such as charcoal-making, hunting small game, and other illegal extraction. This was partly due to the need for quick cash, as these non-farm sources of income satisfied this short-term necessity. Such strategies and needs are a reaction to the recent history of local socioeconomic change. There was less overall interest in less interest in farming in recent years, especially with younger ribereños. The feeling that agriculture was no longer worth the effort to earn a living was common in this area.

By isolating a single extension project from the broad PNCC regional program and examining the project at the household level, we are able to better detect more specific characteristics of these ribereños and their decisions to participate in the PNCC. The significance of the opportunistic planters (a sub-group of non-adopters) in the CASPI project also helps explain the overall problem of limited community participation and non-adoption of camu camu planting across communities participating in the PNCC.

The recent development project boom in the CASPI project area has given most households considerable experience with these projects, leaving them with well developed attitudes and perceptions of these institutions. Residents of these communities have become increasingly skilled in their efforts to deal with the arrival of these organizations. This is reflected by the contingent nature of their response and efforts to impose conditions on the NGO. More research is needed to understand the impact on households of this growing reality in the Peruvian Amazon.

As with the community level analysis of the PNCC in the previous chapter, the household level analysis in this chapter revealed the same serious institutional problems with the CASPI project. Non-adopters were especially concerned about previous failures with other CASPI projects in their villages, and often were excluded from the new camu camu project. One lesson from this experience is that the management of farmer groups needs to be better adapted to different social and agricultural settings. The other obvious lesson is that extensionists and their institutions must refrain from making promises that they cannot keep.

The PNCC inventories conducted to verify the existence of camu camu fields were found to be incomplete in the CASPI project area. A greater number of families were cultivating camu camu over a larger total area than the PNCC reported in 2002. More than double the number of families and area that was the PNCC reported in 2002 was found to be cultivated in the CASPI project.

Camu camu fields were found locally in small in numbers, and widely dispersed over the expanse of the CASPI project area. The existence of wild camu camu may help the diffusion of camu camu in local areas. This is similar to the pattern of diffusion found across the region. It is far too early to know if camu camu cultivation will replace extraction in the wild, but the findings here indicate that this non-timber forest resource has experienced an important start to becoming a widely cultivated tree crop.

The decision to plant camu camu was not always permanent. Household attributes help explain levels of participation in agroforestry projects, but the attitudes and outlooks of individuals in each community may strongly influence the diffusion and permanence of new innovations such as camu camu planting. Planners should allow for farmers to experiment with tree planting in step-wise experiments, especially if they are adding tree species to fields of annual crops.

Camu camu adopters were often self-described experimenters, and spent their lives experimenting with many vocations. Their love of working the land was obvious, which might help explain why their floodplain fields were significantly closer to their homes than the fields of non-adopters. Age cannot be dismissed as a factor in camu camu adoption, and it was observed that older ribereños experimented more often with camu camu planting. These local experts may play a key role in the diffusion of camu camu over the course of their lifetimes. More research is needed understand the local influence of these exceptional individuals.

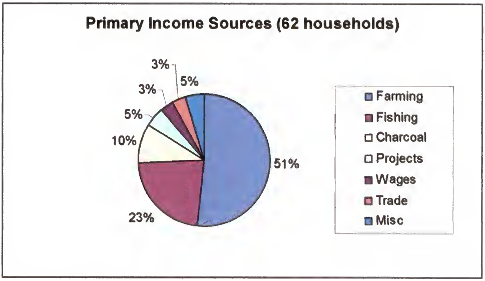

Figure 4-1. Primary sources of household income (62 households).

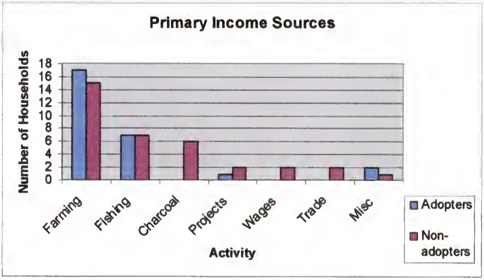

Figure 4-2. Comparing sources of income between adopters and non-adopters.

Adopters n = 27	First answer	Second
To have an additional income	9	5
It was the NGO idea	3	0
High price of camu camu	2	2
NGO promises	2	3
Expected aid	1	5
A friend's advice	1	0
Seeds given out	1	1
To have my own CC	1	0
CC buyer convinced me	1	0
Already working for CASPI	1	0
It is a government rule	1	0
Just arrived in village	1	1
New industry market	1	3
Agreed to acquire the field	1	0
Saw neighbor doing it	1	0
Permanent buyer/industry	0	1
Conflict over wild CC	0	1
To have an additional harvest	0	1

Table 4-1. Adopters' reasons for planting camu camu.

Non-adopters n = 35	**First reason**	**Second**
No aid or credit	11	8
Too much work	3	4
Lack of suitable land	3	0
Not CASPI members	3	0
Saw past failures of CASPI	2	2
Sediment problems	2	2
Could not enter group	2	1
CASPI promises broken	2	0
Industry promises broken	1	3
Just arrived	1	0
Income during flood period	1	0
Dislike of CASPI	1	0
Works for other NGO	1	0
Never received plants	1	0
Did not know how to do it	1	0
Occupied with other work	0	5
Conflict over wild CC	0	2
Punishment by CASPI	0	1
Bad seeds	0	1

Table 4-2. Non-adopters' reasons for not planting camu camu.

Opportunists n = 16	**First answer**	**Second**
No aid or credit came	8	5
Sediment problems	2	0
CASPI promises	2	0
Just arrived	1	0
Income during flood period	1	0
Too much work	1	2
Industry promises	1	3
Conflict over wild CC	0	2
Punishment by CASPI	0	1
Bad seeds	0	1

Table 4-3. Opportunistic participants' reasons for planting and abandoning their camu camu.

Never planted n = 19	**First reason**	**Second**
No aid	3	3
Lack of suitable land	3	0
Not CASPI members	3	0
Saw past failures of CASPI	2	2
Too much work	2	2
Could not enter group	2	1
Dislike of CASPI	1	0
Works for other NGO	1	0
Never received plants	1	0
Did not know how to do it	1	0
Occupied with other work	0	5
Sediment problems	0	2

Table 4-4. Non-adopters' reasons for never planting camu camu.

Years in Community	Median	Mean	Std. Deviation
Adopters (n = 27)	37	38.8	18.853
Non-adopters (n = 35)	35	35.7	16.162

Table 4-5 Years spent in communities by household heads.

Children per household	ALL	Adopters	Non-adopters
Mean number per household	3.2	3.11	3.28
Median number per household	3	3	3
Std. Deviation	2.174	2.486	1.933
Range between households	0-8	0-8	0-8

Table 4-6. Number of children living in households.

Children per household	ALL	Adopters	Non-adopters
Mean number per household	2.06	2.07	2.06
Median number per household	2	2	2
Std. Deviation	1.764	1.999	1.589
Range between households	0-6	0-6	0-6

Table 4-7. Number of children aged ten or older living in households.

Household holdings	All fields	Floodplain fields	Upland fields
Total number of fields (n)	263	182	81
Mean number of fields per household	4.24	2.94	1.31
Median number of fields per household	4	3	1
Std. Deviation	2.086	1.736	1.532
Range in number of fields between households	1-11	0-10	0-5

Table 4-8. Land holdings (number of cultivated fields) for all households (n = 62).

Household holdings	All fields	Floodplain fields	Upland fields
Total field area (ha)	200.05	115.3	84.75
Mean field area per household	3.227	1.86	1.367
Median field area per household	2.75	1.5	1
Std. Deviation	2.153	1.21	1.856
Range in field area between households	.5-11.30	0-5	0-8.75

Table 4-9. Land holdings (total cultivated field area) reported for all households (n= 62).

Household holdings	All fields	Floodplain fields	Upland fields
Total number of fields (n)	124	87	37
Mean number of fields per household	4.59	3.22	1.37
Median number of fields per household	4	3	1
Std. Deviation	1.927	1.717	1.597
Range in number of fields between households	2-10	2-10	0-5

Table 4-10. Land holdings (number of fields) for adopter households (n = 27).

Household holdings	All fields	Floodplain fields	Upland fields
Total number of fields (n)	139	95	44
Mean number of fields per household	3.97	2.71	1.26
Median number of fields per household	4	3	1
Std. Deviation	2.156	1.741	1.502
Range in number of fields between households	1-11	0-6	0-5

Table 4-11. Landholdings (number of fields) for non-adopter households (n = 35).

Household holdings	All fields	Floodplain fields	Upland fields
Total field area (ha)	100.15	60.15	40
Mean field area per household	3.7	2.22	1.48
Median field area per household	3	2	1
Std. Deviation	2.068	.999	1.894
Range in field area between households	1.35-11.3	.5-4.5	0-7

Table 4-12. Land holdings (field area) of adopter households (n = 27).

Household holdings	All fields	Floodplain fields	Upland fields
Total field area (ha)	99.9	55.15	44.75
Mean field area per household	2.85	1.58	1.28
Median field area per household	2.5	1	1
Std. Deviation	2.172	1.294	1.849
Range in field area between households	.5-10	0-5	0-8.75

Table 4-13. Land holdings (cultivated field area) of non-adopter households (n = 35).

CHAPTER 5

LAND USE SYSTEMS AND CAMU CAMU: THE CULTIVATION AND DOMESTICATION OF A NON-TIMBER FOREST RESOURCE

Introduction

New initiatives in agroforestry are giving increasing importance to the domestication of indigenous trees whose products have been traditionally gathered from the forest in order to achieve substantial increases in the quantity and quality of produce (Simons 1992, Leakey and Simons 1998). The domestication of indigenous trees of the Amazon is also viewed as a way for farmers, buyers, and processors to benefit, alleviate poverty, and as a means of sustainable development (Leakey and Tchoundjeu 2001). Domestication of these trees can help to avoid the boom and bust economy that has been the fate of many their products (Clement 1993, Prance 1994). However, escaping poverty through agriculture often causes farmers to deforest greater amounts of land, and degrade the environment in a variety of ways (Wunder 2001). At the same time, the domestication and industrialization of trees in Amazonia brings with it a risk of pest and disease problems (Clement 1993).

The cultivation of camu camu for industry throughout much of the Peruvian Amazon began in earnest in 1997. Despite a number of experiments with camu camu in test plots in Peru, extensive cultivation of the tree is a new event. With the rapid initiation of the Program Nacional de Camu Camu (PNCC), researchers there acknowledge that there will be much to learn about *M. dubia* as an agricultural crop. This learning is both exciting and worrisome because it must now take place in farmer's fields, as camu camu currently undergoes an extensive domestication process (Riva and Gonzales 1997, IIAP 2001). With no evidence of an extensive history of domestication, or even semi-domestication for camu camu, the PNCC suddenly thrust camu camu onto the agricultural landscape of the Peruvian Amazon for these processes to develop, for better or for worse.

Myrciaria dubia is not the only tropical, woody perennial currently undergoing a cultivation program in Peru for export markets. Along with camu camu, government and private entities have recently promoted the extensive cultivation of *Uncaria spp.* ("uña de gato") and *Bactris gasipaes* (palm heart) by farmers in order to supplant wild sources of these non-timber forest products (Villachica et al. 1998, Salo and Torres 1998, Riva 2001). Government reports have provided useful information about initial farmer response to these programs through the publication of statistics and popular literature, but the information is redundant and limited in scope (de Jong et al. 2000). Findings thus far from this dissertation show that in the case of camu camu, such reports can also be misleading (Chapters 3 and 4).

Despite efforts at promotion, we should not be surprised when new crops fail to be adopted by farmers in the region. Floodplain communities in the Peruvian Amazon have a history of resisting external pressures, including agricultural programs, and choose to adapt to circumstances in their own, unique ways (Pinedo et al. 2000). Researchers at IIAP (2001) have reported some of the basic cultivation methods used by farmers with camu camu, but this is mostly economic investigation, oriented toward the PNCC planting scripts. Meanwhile, the need to understand local variations in agroforestry practices in Amazonia is a concern for researchers and development agencies (Chibnik 1994, Pichón 1996, de Jong 1996, Coomes and Barham 1997, Smith et al. 1998). With camu camu in Peru, we again see this pressing need. Pinedo-Vasquez and Pinedo-Panduro (2002) have noted some of the ways ribereños initially experimented with camu camu, but provide no analysis of the agroforestry systems which developed from the PNCC. What are the important characteristics of farmers' fields planted with camu camu, what explains these attributes? Planting camu camu was not a local custom, so it is important to examine how it was integrated into the local land use practices. Exactly how was camu camu being domesticated? What criteria were used for selecting planting stock? With what other plant species is camu camu growing? Is camu camu planting responsible for deforestation? There is a need to answer these and many more questions.

In this chapter, a brief discussion of some aspects of plant domestication in the Amazon relevant to the case of camu camu is presented. Next, results from inspections of camu camu fields are presented in order to understand how camu camu is being cultivated and the basic aspects of the current domestication process. Questions of land preferences, agroforestry practices, pests and diseases, and selection of planting stock are addressed. This chapter examines what lands were used to plant camu camu, and explains how the tree crop was incorporated into agroecosystems through variation in farmer practices. The preliminary findings presented here will help improve our understanding of farmer strategies in cultivating camu camu; and how these strategies, meshed with the planting scripts of the PNCC, have initiated processes of domestication. I also examine the environmental implications of this new form of land use on the floodplain.

Plant Domestication: Perspectives and Relevance to Camu Camu

Defining Domestication

Utilizing the many definitions and descriptions of what a domesticated plant is can sometimes lead to conflicting conclusions. Cultivated crops originated in human selection and propagation of a more useful form of a wild plant (Wrigley 1969), and most scientists agree that cultivation *is* domestication (Willcox 1999). In other words, human intervention through artificial selection is the principal evolutionary force (Casas et al. 1996). *Cultivated* plants undergo a process of cultivation, which is planting, or tending plants and their environment. This does not necessarily mean its genotype is different from the genotype of plants growing in the wild (Nabhan et al. 2000). True domesticates or *cultigens* are crops which are dependent on human interference to complete their lifecycle (Cotton 1996).

It is not the purpose of this dissertation to analyze interpretations of the term *domestication*, but to understand the implications of the findings from this study of camu camu domestication. For this dissertation, the following three aspects of plant domestication are most relevant: 1. In genetic terms, domestication is accelerated and human-induced evolution (Leakey and Tchoundjeu 2001). 2. The critical feature of domestication is how humans improve their crops by sowing selected seeds and planting stock (Nabhan et al. 2000). The most immediately apparent change under domestication is in morphological characters such as shape, size, and color, particularly in the part of the plant used by humans (Pickersgill and Heiser 1976).

Early Accounts of Plant Domestication in Amazonia

One of the most important figures in tropical agriculture, Carl Sauer, considered the humid tropics to be a hearth of domestication in the Americas, against the opinions of others (Denevan 1992). Fruits from neotropical forest trees have been selected and cultivated for at least eight thousand years (Smith, Jr. 1966), although there has been a debate for some time over methods used to determine exactly what constitutes human selection (e.g., Johannessen 1966, Pickersgill 1977). Recent evidence from the Amazon indicates that Vitamin C-rich fruits such as "concona" (*Solanum sessiliflorum*) have been undergoing a long process of domestication resulting in an exceptional diversity of shapes and sizes of the fruits (Salick 1992). The domestication process of tropical tree crops may have started when hunter and gatherers enriched certain campsites or trails with the species. However, the origin of some of the best known tree crops in Amazonia, remains obscure, as does the reason for their early domestication (Smith et al. 1992). This is in part due to lack of archaeological evidence because conditions in the humid lowland tropics seldom favor preservation of identifiable archeobotanical materials (Pickersgill 1977, Goulding et al. 1996).

As soon as European explorers arrived in the Amazon, they noticed Indians cultivating plants (Patiño 1963, Denevan 1992). While it may be difficult to ever discover the exact techniques pre-Columbian Amazonian Indians may have used to select and cultivate crops (whether in the forests or in cleared lands), explorers accounts of early international trade from the Amazon describe how Indians managed some NTFPs. This was through direct planting, selection, and promoted growth. The words "conservation" and "sustainable use" may not have been used as they are today, but valuable plant species were managed in order to maintain supplies. For example, Indians would selectively harvest salsaparilla roots, leaving a couple in the ground for regeneration (Spruce 1970). This is a clear process of selective harvesting, promotion of growth, and cultivation in the forest. In the Peruvian Amazon, Marcoy (1875) also noted the custom of exchanging of fruits, seeds and planting stock. What is certain is that with the cultivation of Amazonian plant species for export markets, some were plagued by infestations of disease and pests. Two of the best known examples of tree crops, cacao and rubber, made an early exit from Amazonian environments because their extensive cultivation had increased problems with disease (Smith et al. 1992).

Domestication of Amazonian Tree Crops and the Case of *Bactris gasipaes*

One of the more common tree crops in the Peruvian Amazon is *Bactris gasipaes*, or peach palm. The origin of the peach palm is obscure (Smith et al. 1992). Known as "pupuñha in Brazil, it is commonly called "pijuayo"in Peru. Sauer (1952) noted decades ago that *B. gasipaes* was a domesticated palm no longer existing in the wild form. William Henry Bates (1962) made a similar observation in Brazil over 150 years ago, stating that pupuñha grew wild nowhere in the Amazon. People probably quickly took notice of this because you can so readily observe the domestication process simply by examining the striking, obviously human-induced variation of the fruits (Johannessen 1966).

With such a history, it may seem logical, yet somewhat ironic that *Bactris gasipaes* was recently identified by ICRAF as a priority tree species for domestication in the Peruvian Amazon (Leakey and Simons 1998). This shows again the vagaries of the term "domestication". What the authors are referring to in this case are rapid genetic improvements that will make "major leaps" (p. 167), rather than the incremental improvement that has already taken place on farms. This also illustrates agricultural attitudes about variation in crops, and the tendency towards uniformity in crop varieties that Williams (1993) describes as all too characteristic of modern agriculture and marketing. The case of peach palm suggests that there is little reason to believe that widely distributed trees with edible fruits may not have been at least semi-domesticated by humans. If so, what can we learn from camu camu?

Domestication and Camu Camu: Searching for Clues

Extensive archival research by Patiño (1963) gives accounts of early explorers sampling acidic fruits from small trees, some of which were in the forest, and others cultivated by natives. Like camu camu, the fruits were often too acidic for the hungry men to enjoy. Many of these were said to be *Myrtacea*, and bitter wild guavas (ibid.), but none of the descriptions indicates that they were harvesting the fruits from the waterside, or eating *M. dubia*. What is not clear is if these men may have been trying fruits from the larger tree forms of camu camu, but the descriptions leave open the possibility. During this dissertation research, I was surprised at the lack of evidence for either Indians or explorers consuming the fruit (Chapter 2). It is hard to believe that a tree with such plentiful fruit growing on the floodplain could escape human efforts at cultivation, but this implies that *M. dubia* may have experienced relatively little selective pressure from humans, at least compared to the more popular fruits found alongside camu camu in the Iquitos markets.

Selection pressure exerted by the environment will cause significant morphological changes in fruits, while weak selection pressures result in little evolutionary change

(Johannessen 1966, Pickersgill 1977.). This suggests that the very uniform characteristics of camu camu fruit throughout Peru may be explained by the specific habitat of *M. dubia*, which is found exclusively in riverine, floodplain environments. With the larger species of *Myrciaria* such as “camu camu de árbol” or “shahuinto”, there is much variation in the morphology of the trees and their fruits (Chapter 1). Unlike *M. dubia*, these trees are found in a wide variety of floodplain environments, rarely in dense stands, and are quite often solitary, growing far from the nearest neighboring specimen. Unlike *M. dubia* which fruits every year, these trees usually fruit in alternate years or in more sporadic fashion. This implies a broader range of environmental selection pressures for these trees than for *M.* dubia, which may help explain their stronger variation. While there is yet to be evidence for early human cultivation, such a tree might naturally lend itself to protection in gardens because it so often appears spontaneously.

It is well known that people have been altering the forests to help useful species grow for millennia, and that these forests are thus anthropogenic to a certain extent. Therefore, these plants have “manipulated” the environment just as humans have manipulated them (Politis 1999, Smith 1999). If natives were using camu camu fruits only as fish bait, and the small tree for firewood and construction, such utilization might alter these oligarchic riverine forests, but perhaps in ways that would be more difficult to detect than with other trees, such as palms. Baiting might disperse the seeds as fish would disperse them, but the expansion and contraction of camu camu forests has yet to be understood. Cuttings from many floodplain trees will survive when shoved into the ground, but this does not appear to be true for camu camu, much to the chagrin of the PNCC. Seeds in the guts of fish caught by humans might have been dispersed away from riversides, but *M. dubia*, unlike the larger tree forms of *Myrciaria,* seems to have great difficulty establishing itself outside of its habitat.

This attempt to explain some of the obvious morphological differences and locational attributes in species of *Myrciaria* referred to as "camu camu" demonstrates the need for further genetic and ethnobotanical research. Like many other tropical tree crops, researchers will probably only begin to understand the genetic attributes of camu camu after widespread commercialization has already taken place (Smith et al. 1992). Thus, if domestication implies human control over plant breeding as described by Nabhan et al. (2000), this scenario can hardly be described as "control". This raises the question as to what planting stock was used in the PNCC, and with what selection criteria.

Selection of Camu Camu for the Planting Program

Seedling Nurseries

Researchers at IIAP recommended that seeds from the processing plants be used to grow seedlings in nurseries located in the participating communities. The advantage to this method is that it was quick and low cost, and the genetic diversity of the fields planted with camu camu would be high because the seeds came from all over the Peruvian Amazon. This broad genetic base would help protect against diseases and pests (IIAP 2001). The processing plants were ordered to provide seeds to any group or individuals that requested them[1].

When the processors gave out seeds there was no selection of the seeds. The PNCC utilized seeds with a presumably wide genetic base because they came from all over the region. These were then spread across floodplain communities from the Putumayo River in the north to the Pucallpa area in the south. In an odd way, it appears that the initial extensive domestication of camu camu by the PNCC may have promoted the genetic diversity of camu camu fields, not by traditional human selection, but by the mixing of seeds at processing plants and their redistribution to farmers.

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[1] During the non-harvest season of May-October, seedlings would be sold by some of these firms.

It was in the nurseries where human selection took place. Most of the seeds from the processors were immature and did not germinate, as the fruit was usually harvested in a semi-ripe condition. IIAP (2001) recommended that the seedlings be at least 30cm high before transplanting to fields. Farmers reported that they always selected the largest, most vigorous plants, even if they had not yet reached the prescribed height. My personal observation was that these often came from very ripe fruits with larger seeds. Thus was the nature of this incipient or initial domestication program for camu camu.

Domestication in Progress

Near Iquitos, INIA currently maintains 24 varieties of *M. dubia* at its experimental station at San Roque, while IIAP has maintained five varieties at its Pucallpa station (Villachica 1996, Picón and Acosta 2000, Riva 2001). Researchers there explained to me that these plants came from 29 different locations in the Peruvian Amazon, but the genetic differences have yet to be determined. The first data on yields came mostly from experimental plots. The productivity of these 29 varieties is under study (Riva and Gonzales 1997), and seeds are kept in a liquid solution for 18 months and then discarded.

A large number of grafts were made in Pucallpa during 1995-97, and a small amount in Iquitos. The purpose of the grafting was to produce trees which would mature very quickly compared to seedlings, often two years after being transplanted planted in fields. I was told that this effort was made without selecting the root stock or scion for any desirable traits, but to get as many grafts as possible quickly made with the plants that they had on hand. Once again, it appears that the matter of urgency resulted in the mixing of genetic stock.

I inspected twenty fields in the vicinity of Pucallpa, and six of the fields (30%) contained grafted stock, from 30 to 900 plants. Five of the six fields had mixed in seedlings from nurseries. I had thought that the gift of grafts would motivate farmers to keep their fields in prime condition, but this was not true. Three fields were in good condition, two were fair, and one was poor.

Fifty of the 89 fields of camu camu I surveyed (56%) were managed by families with access to wild camu camu fruit, and they also made ample use of the wild plants. Forty-three of their fields (86%) were partially stocked with wild plants, and four of these fields consisted of entirely wild plants.[2] Plants were selected by pulling out juveniles that were about one meter in height, and those that would come out easily with minimal damage to the roots. In this case, planting stock was selected by extension agencies and farmers for speed and convenience. Like the distribution of seeds to the community nurseries, the situation prevented the selection of planting stock based on desirable traits such as productivity or quality of fruits.

New Strategies for Improvement of Camu Camu

Peru has a history of cultivating non-timber forest resources (NTFRs) for their chemical properties. The early efforts to manage chinchona for quinine immediately comes to mind, but success was limited (Dourojeanni 1990). By 1930, there were successful efforts to cultivate "barbasco" (*Lonchocarpus* spp.) in Peru, and planting stock was selected for a minimum concentration of rotenone (usually 8%), so that it could be used as insecticide. This effort helped sustain a small "boom" in barbasco exports from Peru during the 1930s and 40s, and the industry experienced a re-birth in the 1960s (Wille et al. 1937, Villarejo 1979). Peru is currently exporting another NTFP for its chemical properties, uña de gato bark, which is also being cultivated as an alternative to wild sources of the woody vine (de Jong et al. 2000, Lock Sing 2001).

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[2] This includes one farmer who had no access to wild fruit, but he traveled to a camu camu forest after the harvest season to procure his own plants.

With camu camu, IIAP has decided to implement a plan for improving its cultivation by selecting plants based on two criteria; the vitamin C content of the fruit, and the productivity of the tree. The plan has yet to materialize and details are lacking, but the idea is to obtain the most productive plants possible with an ascorbic acid content of at least 2700mg per 100 grams of fruit pulp (Pinedo 2002). In this sense, the fruit is being treated more like a chemical product than an edible fruit.

Variations Observed in Cultivated Camu Camu

Myrciaria dubia reaches six to eight meters in height. Normal, mature leaves from adult camu camu plants can reach a size of about 6cm wide by about 10cm long (Peters and Hammond 1990, IIAP 2001). In two fields, productive plants five years in age were observed with very small leaves, just 2.5 cm wide, and 7.5 cm in length. Trees with such small leaves were not observed in the wild. Conversely, in four fields, plants of the same age were observed with very large leaves, measuring 12.5cm in length, and 7.5 cm in width. In one field, three of the trees had leaves 6.2 to 6.4 cm wide, and 14.1 to 14.3 cm in long. Camu camu with such exceptionally large leaves and fruits were observed in the Putumayo River. This suggests that the some of the seeds in these four fields might have been from the Putyumayo. However, it was impossible to determine this, and may still be without the aid of genetic proof. Still, the exceptionally size of the leaves from these fields is even more impressive when compared to that of 13 year old camu camu, by far the oldest cultivated trees in the study area. These trees had come from wildings in the Tahuayo River. The largest leaves on these trees measured 3 to 3.8 cm in width, and 9.7 to 10.1 cm in length.

I also observed that some trees were quite narrow in form, while others had a wider, more branched architecture. Farmers were pruning the trees to varying degrees, making it difficult to arrive at conclusions about their development. Most trees that were well weeded were from 2.5 to 3.5 meters in height, and all had a DBH of less than 5 centimeters. The 13 year old camu camu in one field had a mean height of 6.42 m, and were quite uniform in height despite no pruning in at least five years (range 5.95 to 6.65). The trees had a mean DBH of 6.36 cm, with one measuring less than 5 centimeters, and one tree having a DBH of 10.2 cm. There was no correlation between tree height and DBH ($r = .383$). This is just one very small sample, but the trees exhibited more variation in trunk size than they do in height, which is typical for wild camu camu.

Obviously, the trees will exhibit some variation in growth and structure depending on different soil conditions[3]. Camu camu does exhibit some variations in growth between soil types, especially between uplands and floodplain environments. However, this data is limited and more research is needed to determine any distinct patterns that may exist (Riva and Gonzales 1997).

In the wild, *M. dubia* usually fruits between the months of November and March, with the heaviest periods during December through February (IIAP 2001). This varies somewhat from year to year, and by location. For example, fruits from the Putumayo River, which drains later than most other major rivers in Peru, ripen from late January through March, and even through May. I observed fruits on the trees there during June. Fruits from the Tahuayo River are documented as having a well-established, tight cycle of late-December through early February (ibid.), but I observed abundant fruits there during the month of November, and also during April. Reports from residents indicate that fruiting periods will vary from year to year, and records obtained from the community show that large harvests were sent to Iquitos during April 2001 and November 2002.

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[3] Dr. Hugh Popenoe, Department of Soil and Water Science, University of Florida, personal communication, 2002.

With cultivated camu camu, the fruiting period appears to be more spread throughout the year, and two fruiting cycles can occur. Camu camu planted in the study area nearest to Iquitos tended to fruit somewhat later in the year than the local wild trees, with most fruit harvested in January through March, and then often again in June and July. These fields have just begun to produce, so it will be several years before we will better understand the phenology of domesticated trees.

In the Pucallpa area, where *M. dubia* does not exist in the wild, most fruiting takes place during August through October, with a smaller crop in January through April. However, one family that had experienced two significant harvests of over 400 kilos of fruit from their fields insisted that the biggest harvest always came in April. Many farmers there told me that camu camu will produce at least some fruit for most of the year. It should be noted that unlike Iquitos, Pucallpa has a pronounced dry season, from late May through September. I was surprised to see the lack of stress in this water-loving tree there during the dry season, when dust blows throughout the area. Again, the domestication process of this species is just beginning, and our knowledge of its characteristics under cultivation can only improve with time. Despite the rather uniform appearance of camu camu trees, variations in plant phenology and morphology were readily apparent during the field surveys. It must be remembered that domestication is not only about selection and breeding, but production and management, and how farmers adopt these trees (Leakey and Tchoundjeu 2001). Therefore, when examining the nature of camu camu domestication, we cannot overlook these important aspects of cultivation.

Field Surveys: Methods

A representative sample of 89 camu camu fields were studied from the upper Putumayo River, the Tahuayo-Muyuy and Jenaro Herrera areas, and the Pucallpa vicinity. Farmers reported that these fields represented around half to two-thirds of all fields containing camu camu in the study areas. Dimensions of fields were measured with tape measures in order to estimate total area of each field. The spacing between planted camu camu trees was measured with tape measures, and the distance of fields to the river side was measured by counting paces. Height of camu camu was measured with a tape measure, and diameter was measured with a diameter tape. Planting density, associated crops, and presence of pests and diseases were counted in $10m^2$ plots.

Farmers assisted me with this work, and their input helped define the conditions of the trees and fields. Incidence of pests and disease was determined by observing the camu camu trees for the presence of these maladies. "Presence" meant that they were readily observable to the naked eye. Field conditions were defined as excellent, good, fair, and poor. Excellent fields were well-weeded, with associated annual crops free of weeds and the camu camu not in need of any further maintenance for at least four months. Good fields were defined as fields where weeds were prominent, but no more than half the height of the camu camu. A fair condition meant the weeds had nearly reached the height of the camu camu, engulfing them, and immediate weeding was necessary to prevent damage to the trees. Poor conditions meant weeds were as tall or taller than the trees, pulling them down, or in the process of smothering them. Statistical analysis is provided when relevant.

Comparing Fields From Contrasting Locations

Of the 89 fields surveyed, 46 (52%) were located within the Tahuayo-Muyuy area, and 43 fields (48%) were located well outside of this area. The Tahuayo-Muyuy area corresponds to the CASPI project area, but 19 of the 46 fields surveyed in this area (41%) were efforts independent of the CASPI project as explained in the previous chapter. This area is distinct because it is situated within one day in travel time from Iquitos, and is therefore subject to the particular market forces from this large urban area. Much has been written about the market-oriented agroforestry systems managed by ribereños of this area (Hiraoka 1986, Padoch and de Jong 1987, 1989; Coomes 1995, Coomes and Burt 1997). Iquitos is also well known as a strong market for an exceptionally diverse number of fruit crops, unequaled in the Peruvian Amazon (Padoch 1988b, Vásquez and Gentry 1989). In the other group of 43 fields, slightly less than half 20 (47%) were located within a one day travel time from Pucallpa. Pucallpa is an important market for fruits, but the produce markets there exhibit less diversity in fruits and appear less dependent on production from local market-oriented agroforestry systems than Iquitos. Pucallpa markets are filled with avocados, beans, potatoes and other crops trucked in directly by road from the Andes and coastal regions of Peru. Large amounts of mangoes and citrus are also brought in from orchards found along the road to Lima. What is important here for the purpose of comparison is that we have one group of fields located close to the distinct Iquitos market, and another group that is not, with less than half the fields in the latter group located close to any urban market. Thus we have two distinct samples of camu camu fields, roughly equal in size, making it possible to compare fields under characteristic “Iquitos market conditions” to the other group of fields.

Planting Recommendations

The PNCC felt it was necessary to promote a specific method for cultivating *M. dubia* if the program was to be successful. The Instituto de Investigaciones de la Amazonia Peruana (IIAP) was the government research institute that made official recommendations about how camu camu should be cultivated. This office of IIAP, called the “Programa de Bio-Export” recommended that camu camu should be planted in floodplain environments, on low restingas. Restingas are old fragments of river levees, and low restingas ("restinga baja") are usually flooded annually by some one to two meters of water. This phenomenon maintains soil fertility, and limits the development of weeds, pests, and diseases. Utilizing low restinga landscapes greatly reduces the effort needed to cultivate camu camu, and the national program made this policy (IIAP 2001). Nevertheless, camu camu will grow well in a number of Amazonian landscapes, and it has been planted in both floodplain and uplands (Vásquez 2000). Researchers have promoted camu camu cultivation in uplands to avoid losses of fruit from exceptionally high or early floods (Villachica 1996). Researchers at IIAP were critical of this strategy, as weeding required more labor, soils were less fertile than floodplain soils, and they felt pests or disease infestations would become too severe.

Researchers at IIAP also determined that optimal planting distance in low restingas is two meters between trees, in rows three meters apart. This allows the farmer to cultivate space-demanding but important annual crops such as manioc and melons between the trees during the first five years, increasing productivity of the field by use of this agroforestry system. Legumes and other vegetables were also be part this arrangement. The fields needed to be located away from riversides, where erosion or heavy sediment deposits can destroy them (IIAP 2001).

Land Use and Camu Camu Cultivation: Results

Selection of Lands

Forty-two of the 89 fields surveyed (47%) were located in low, very humid landscapes of the floodplain, called "bajeales". Twenty-six fields (29%) were located on riversides, seventeen were on low restingas (just 19%), with two fields on high restingas and two in non-flooding uplands (Figure 5-1). Comparing the Iquitos area to the non-Iquitos area, we see that a higher percentage of the Iquitos area fields were located on riversides than non-Iquitos areas (40% versus 21%), while fields in the non-Iquitos area were more often located on bajeales than Iquitos area fields (58% versus 40%).

Fifty-one of the 89 fields (57%) were started on lands that were already occupied by cultivated fields. Twenty-one camu camu fields (24%) were cut from young fallows (less than 5 years in age), five were cut from fallows older than five years, and nine fields (10%) were cut from mature forest (Figure 5-2). Almost two-thirds of the Iquitos area fields were planted in cultivated lands (65%), compared to 49% of the non-Iquitos area fields. Overall, the use of fallows to plant camu camu was about equal between the two samples (33% for Iquitos area fields, versus 33% for non-Iquitos area fields). However, it was more common for the Iquitos area fields to originate on *young* fallows than non-Iquitos area fields (33% versus 21%). Only one field in the Iquitos area was cut from mature forest, compared to eight fields in the other group of fields.

Field Distance from Rivers

A typical camu camu field was located just 50 meters from the nearest river (median; mean 140.6, SD 198.028) (Table 5-1). There was wide range in distance (1-700m), but no field was located more than 700 meters from a river, and 77% of fields were located 150m or less from the edge of a river. Iquitos area fields were located significantly closer to riversides than the other group of fields ($t = 2.069$, df 87, $p < .05$). All but nine of the Iquitos area fields (81%) were located 100m or less from the edge of a river.

Field Distance from Farmer Homes

Fields ranged from one minute to nearly an hour in travel time (by foot, canoe, or both) from the homes of their owners (Table 5-2). The minimum distance value presented here is one minute, although some fields could be reached in less than a minute by making a conscious effort. A typical field was located 10 minutes away from the home (median; mean 1.8, SD 11.858). The Iquitos area fields were located significantly closer to owner homes than the other group of fields ($t = 4.46$, df 87, $p < .01$).

Field Area

A typical field planted with camu camu was less than one-half hectare in size (median .45, mean .67, SD .6) (Table 5-3). Fields from the non-Iquitos area were significantly larger than Iquitos area fields ($t = 3.828$, df 87, $p < .01$). Only eleven fields were over 1 hectare in size (12%), but ten of these were from outside the Iquitos area. Of the eighteen fields less than .25 ha in size, two-thirds (12) were in the Iquitos area.

Planting Density of Camu Camu

The seedlings were planted in rows and patterns within the fields. In three-quarters of the fields (75%) the trees were planted at a distance of roughly three by three meters. Spacing was imprecise, and could vary between rows and within rows. In a typical field, twelve trees were counted in the $10m^2$ sample plot (median; mean 15.52, SD 11.825). Iquitos area fields had a higher mean density of trees than the other fields, but a typical field in both areas still had twelve trees in the sample plot, or 1200 trees per hectare (Table 5.4).

Seventeen fields (19%) were planted with a spacing of less than three meters (eight in the Iquitos area and nine in the other area), while five fields (6%) were planted with a wider spacing (two in the Iquitos area and three in the other area). Several fields were densely planted with the trees, and four fields had more than forty plants in the sample plot. Fields that were in poor condition often had a lower planting densities, as did fields that had gaps in the rows.

Land Use: Discussion

The findings here indicate that most farmers attempted to follow the IIAP planting scripts for camu camu within their fields as far as the spacing of the trees, but over 80%

did not adhere to the plan when selecting lands for their fields. Less than one-fifth of the fields were located on the recommended low restingas. Nearly half were located in the lowest lands (bajeales) where seasonal flood waters could easily cover the trees during the fruiting period. More than one-third were on riversides, in danger of erosion or sediment damage, directly contrary to official recommendations. This lack of compliance can in part be explained by the heavy use of young fallows and cultivated areas to plant camu camu. The great haste with which the PNCC was initiated pressured the farmers into using readily available or easily cleared lands such as young fallows. At the same time, more than half of the fields were fields were smaller than the prescribed size of one hectare, and many of the larger fields them had substantial spaces in the field that did not contain camu camu. Again, the urgency of the projects was partly to blame. But at the same time, clearing forest is a labor-intensive activity requiring assistance, and most adopters had little inclination to clear new lands for camu camu, or dedicate large pieces of land to the effort (Chapters 3 and 4).

A typical field contained 1200 trees per hectare, quite close to the precise recommended density of 1111 trees per hectare for the PNCC. In most fields the trees were either planted with a spacing of three by three meters between the trees, which was the IIAP recommendation for camu camu that would be intercropped with manioc, rather than the two by three meters pattern, which was recommended for maximum camu camu yield per hectare (IIAP 2001). This shows how most farmers were interested in maintaining annual crops in combination with camu camu, which is not surprising, given the relatively high value of these floodplain lands (Hiraoka 1989). At the same time, sixteen of these farmers (17%) planted camu camu in a much denser fashion. Most of these fields were small (< .25 ha), and started by farmers on their own initiative, without the help of extension agencies. In several of these smallest fields, farmers explained that they were trying to mimic the spacing of young camu camu in the wild. This is yet another example of farmer experimentation, and again shows that interest in cultivating camu camu may continue, but not according to extension recommendations.

Iquitos area fields were significantly smaller in size, closer to riversides, and located closer homes than the other group of fields. This suggests that although the scripted requirements of the PNCC could not be met, farmers were willing to experiment with the new crop on a smaller scale, and closer to home, much like a home garden, as shown in the previous chapter. Home gardens are common and useful places for experimentation with agroforestry in Amazonia (Smith 1996). This smaller-scale strategy is an example of what Bunch (1989) describes as the step-wise nature of farmer experimentation with new techniques. The predominant use of lands other than low restingas was the choice of farmers, many of whom felt the trees would also grow better in this environment. It also demonstrates how farmers have their own unique ways of adopting crops and adapting them to their farming practices. This concurs with Pinedo-Vasquez and Pinedo-Panduro (2002), who also found that ribereño participants in the PNCC preferred to use bajeal landscapes.

Why were fields in the non-Iquitos area so much larger in area? Two factors seem to contribute to their larger area. First, eight of the nine fields cut from primary forest were in the non-Iquitos area, and seven of these were at least one hectare in size. Five were in the small new village of San Gerardo, where people needed to open new lands, and hoped that their participation in the PNCC would help them obtain assistance with agriculture and needed community infrastructure (Chapter 3). Second, eleven of the twenty fields located in the vicinity of Pucallpa (55%) were one hectare or greater in size. From conversations with farmers, this is due to a preference for larger field sizes there that was tied to the need to maintain claims to their land, and because there has been a strong market for their camu camu in Pucallpa.

Fields in communities nearest Pucallpa also exhibited more orderly rows and spacing than other areas. This is because farmers were accustomed to planting annual crops in rows, and some even had at least limited experience with mechanized agriculture. They also used hoes when weeding their fields, the only place in the study where this was observed. The use of pesticides was also common here, and rare elsewhere. This situation points to more intensive land use practices with camu camu near Pucallpa than found elsewhere. However, it is still too early to see if camu camu that is cultivated in such a fashion will prove to be more productive than elsewhere. Lower rainfall in this area may also affect agricultural productivity, and could in fact necessitate this form of land use.

Only 10% of fields were cut from mature forests, demonstrating that in this case, significant deforestation did not occur because of the PNCC. This finding contradicts the hypothesis of Wunder (2000), who believes that expanded markets for NTFRs will cause extractors to cultivate them through deforestation. This also gives credence to the notion that the adoption of agroforestry systems can in provide an alternative to deforestation (Current et al. 1995). However, the findings presented here represent the initial impacts on the floodplain landscapes of the PNCC. If a new boom in camu camu planting occurs, we may indeed see extensive clearing of mature forests to facilitate its cultivation as Wunder (2001) argues.

Field Conditions: Results

Field Age

When I inspected the fields during 2001-2, 43% of fields were said to five years old, meaning camu camu had been cultivated there for five years. A typical camu camu field had been managed with the trees for four years (median; mean 3.81, SD 1.906) (Table 5-5). Most often the camu camu fields were five years in age, reflecting not only the time of the main efforts of the extension agencies and the PNCC projects, but the fact that these fields had already been planted with annuals when camu camu seedlings were introduced. Though the mean field ages were quite similar for both areas, eleven of the 46 Iquitos area fields were just one year in age (24%), compared to none for the other group of 43 fields.

Field Maintenance

Field inspections revealed that a typical field was in "good" condition[4] (median 3, mean 2.8, SD 1.035). About one-third of the fields were in excellent condition (30.3 %), but 21% were in fair condition, and 15% were in poor condition (Table 5.6).

Non-Iquitos area fields were in significantly better condition than Iquitos area fields ($t = 2.241$, df 87, $p < .03$).

Pests and Diseases

Incidence of pests and disease was determined by observing the camu camu trees for the presence of four insect pests that the The BioExport program has identified as prevalent enough to cause significant economic damage to cultivated camu camu, even in a low restinga environment (IIAP 2001). These are *Conotracheius dubiae* ("gorgojo del fruto") which was also common in wild stands, *Tuthillia cognata* (“doblador de ojas”, "piojo"or "pega pega de las hojas"), *Xylosandrus compactus* ("barrenador de las ramas", “leñadero”), and *Edessa* sp. ("chinche del fruto”). The trees were also inspected for a leaf attacking fungus (*Fumago* sp.) commonly known as “caza”.

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[4] A value of 4 = excellent condition, 3 = good, 2 = fair, and 1 = poor condition.

After surveying several fields, it was immediately obvious that the small gorgojo del fruto insect (*Conotracheius dubiae*) was rare. It was eventually found in only one field on two trees, in the Tahuayo River village of Chino. Wild camu camu fruit there was also observed with this insect. The other fruit attacking insect, chinche del fruto, was not found in any of the fields. However, a parasitic climbing plant (*Moradendron* spp.) commonly called “suelda con suelda” or “mata palo” was common in many fields, and considered a problem by farmers. My own observations concurred with this farmer opinion, thus necessitating the inclusion of the plant pest in the surveys.

Twenty-two of 89 fields (25%) were free of observable pests and diseases. In the Iquitos area group, 28% of the fields were found in this condition, compared to 21% of the fields in the other group (Tables 5-7 and 5-8). Of the five maladies encountered in the fields of camu camu, the most commonly found was the insect pest *Tuthillia cognata,* occurring in 46 of the 89 fields (52%). *T. cognata* was more common in non-Iquitos area fields in both frequency of occurrence (70% vs. 35%) and level of infestation in the sample plots (55% vs. 39%). Next in frequency across all fields was the leaf fungus *Fumago* sp., occurring in 30 of the 89 fields (34%). *Moradendron* spp. and *Xylosandrus compactus* were found respectively in 15% and 13% of the fields.

Findings in Table 5-8 show that in fields where the three most common problems occurred, from one-third to one-half of the trees were affected. *X. compactus* was different in this respect, not only less present in fields to begin with, but also much less common in the fields it inhabited. Cattle damaged the trees in two fields, and humans started fires that damaged or killed camu camu in three fields.

Field Conditions: Discussion

Farmer -managed Conditions

The group of fields that were not from the Iquitos area was in significantly better condition than Iquitos area fields. What might explain this difference? While this is a qualitative observation converted to a quantitative measure, and is subjective in nature[5], we cannot rule out the fact that most of these fields were established as part of the CASPI project which was fraught with problems and opportunistic participants. This alone suggests that the results retain their validity and are to be expected. Nine of the Iquitos area fields were in poor condition and the trees were in danger of dying, compared to four of the fields in the other group. Less than one-quarter (22%) of the Iquitos area fields were in excellent condition, compared to 40% of the other fields. I also found that the recent drop in camu camu prices in Iquitos had lessened farmers' motivation maintain their fields, while prices for camu camu in Pucallpa markets remained high (Chapter 7).

Although the mean field ages were quite similar for both groups of fields, eleven of the 46 Iquitos area fields were just one year in age (24%), compared to none for the other group of fields. This situation is explained by the recent experimenting with camu camu in that was discussed in the previous chapter. Adding to this is the fact that Pucallpa area farmers had no source of wild *M. dubia* and were dependent on extension agencies for planting stock. Obviously, the field surveys were a snapshot of field conditions. More research is needed to see how these field conditions may change over time, and how Pucallpa area farmers select and exchange camu camu planting stock.

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[5] Dr. Timothy Fik, Department of Geography, University of Florida, personal communication, 2002.

Pests and Diseases in Camu Camu Fields

Pests and diseases were found in more than three-quarters of the camu camu fields. Slightly over half of all fields (51%) had at least two maladies (usually *T. cognata* with *Fumago* sp.), one-quarter (25%) had three, and one field had four. There was no observable pattern to the incidence of the leaf pest *T. cognata.* Regardless of the level of pests and diseases in their fields, farmers felt that only the parasitic climbing plant *Moradendron* spp. did any damage to the trees.

Farmers explained that with floodwaters, the incidence of these insects and the leaf fungus varied from year to year, but once in a field, *Moradendron* spp. was there to stay. The seeds are dispersed by birds, usually feeding nearby, up on trees where the plant has already established itself. IIAP (2001) considers the shoot-borer *X. compactus* to reduce fruit yields, but farmers clearly disagreed, claiming that the new shoots will produce more fruit. Other pests that were said to damage the trees were leaf cutter ants (*Atta* sp.) and small rodents.

There was a slighter higher frequency of pest and disease-free camu camu fields in the Iquitos area than in the other group of fields. Thirteen of the Iquitos area fields (28%) were free of maladies, compared to 21% in the other group. However, these disease-free fields in Iquitos area were usually quite small (< .25 ha), and planted in the last two years. The young trees were completely covered by floodwaters, and their leaves and branches were still quite small, perhaps too small for pests to make their home.

Fumago sp. was not observed to occur on young, tender leaves. Only one field aged four years or older was free of these maladies in Iquitos area, compared to nine in the other group of fields.

Xylosandrus compactus was found in seven of the fields outside of the Iquitos area, six of which were located along the floodplain of Yarina Cocha, near the city of Pucallpa (Figure 3-1). Five of the fields were in the village of Siete de Julio, and a sixth was in the neighboring village of Padre Bernardo. These six fields all had watermelon or sweet melon intercropped with the camu camu, but the farmers told me that the presence of the pest had nothing to with the existence of these annual crops. *X. compactus* was found in just five Iquitos area fields, four of which were in the Tahuayo River villages of Santa Cruz and Nuevo Valentin, and one located in the nearby Amazon River village of Tapira Nueva I.

Moradendron spp. was found in only two villages outside the Iquitos area; in Pucallpillo, located near Pucallpa, and Santa Mercedes, on the upper Putumayo River. This plant pest was most common in fields located in the villages of Santa Cruz and neighboring Punga, Chino, and Pihuicho Isla (Figure 1-5). It is at least known that this parasitic plant colonizes new, rather than mature forests (Gentry 1993), but it was absent from many fields that were established in landscapes with a history of intensive cultivation. More research is needed to understand the habitat of this plant, as well as the birds which disperse its seeds.

One of the most striking patterns observed was in the villages of Nueva Pumacahua, San Gerardo, and Nuevo Aucayo (Figure 1-6). The latter two villages are located next to one another, quite new, and surrounded mostly by primary forest. All three are near the town of Jenaro Herrera, on the lower Ucayali River. Of the sixteen fields surveyed in these villages, seven were free of pests and diseases (44%). All of these fields were five years in age, and the trees had fruited at least once. What might explain this condition?

Most fields in San Gerardo were cut from mature forest, and those in neighboring Nuevo Aucayo were usually from older fallows. Six of the fields there were pest and disease free, and none of the fields there had more than one pest or disease. Only two of the sixteen fields (13%) had more than one pest. These were from Nueva Pumacahua, located next to the town of Jenaro Herrera, in a landscape characterized by decades of agricultural development. This situation suggests that the surrounding mature forests may have something to do with the low incidence of maladies in these gardens. Other Amazonian tree crops such as cacao and rubber have a history of cultivation within forests in order to reduce the incidence of disease (Smith et al. 1992).

Findings reveal clear patterns for the presence of diseases and pests across camu camu fields existed in the study areas with varying levels of infestations. Some patterns were only noticeable at the regional level, such as the lower incidence of *Tuthillia cognata* within a days travel time of Iquitos. The same is true for *Moradendron* spp., which common in the Amazon floodplain near Iquitos, nearly absent from Ucayali River fields, and again found in the upper Putumayo River. Local patterns can also exhibit a regional aspect. For example, the shoot-borer *Xylosandrus compactus* was rarely encountered, but when found, was concentrated in two distinct localities: 1. Two neighboring villages in the lower Tahuayo River, and two neighboring villages in the

Ucayali River along Yarina Cocha. These two areas were located more than 600 kilometers away from one another.

There is a need for caution when drawing conclusions about the findings presented here. Only the observable presence of these species was recorded, not their true populations. The effects of floodwaters on these species are unknown, although they appear to repress them. For example, farmers reported that high floodwaters meant less incidence pest and diseases the next year, and young camu camu that was fully submerged was observed to be mostly free of these maladies. However, these field inventories provide us with an idea about the incidence of pests and diseases in camu camu fields, which serves as a starting point for further studies. The findings also demonstrate the value of using a large study area spread across the region when attempting to understand the cultivation of camu camu.

Surprisingly, nearly all farmers insisted that these maladies did little, if any significant damage to the young trees. Many insisted that the leñadero insect (*Xylosandrus compactus*) actually helped yields because it caused the trees to produce more new shoots and flowers. The leaf fungus (*Fumago* sp.) does not appear to overly harm the trees, which lose most of their leaves anyway during seasonal floods. The presence of pests and disease is at an early stage in the domestication of camu camu. I also observed that camu camu is certainly not immune from other insects, such as the well known leaf-cutter ant (*Atta* sp.). With time farmers may discover the true effects of these maladies, as well as the presence of several more.

Cropping Associations with Camu Camu:Results

Fifty-five crops were cultivated in association with camu camu. Twenty-one were annual crops, and 34 were perennials. Fifty of these crops were present in Iquitos area fields and 23 in other fields (Table 5-9). Up to 10 crops per field were cultivated in association with camu camu, but slightly more than one-third of these fields (34%) consisted solely of camu camu trees, while 36% contained three or more crops in addition to the camu camu (Figure 5-3). Nearly half of the Iquitos area fields (46%) were observed as mono-cropped orchards, compared to less than one-quarter (23%) of the other fields. Iquitos area fields tended to be either monocultures or diverse in components, while crop diversity was spread more evenly across other fields (Figure 5-4).

Nearly two-thirds of fields (63%) contained less than three crops, and none of the crops associated with camu camu were found to be present in even half the fields surveyed. Manioc was intercropped with camu camu in 30 of the fields (34%), followed by maize in 22 fields (25%), watermelon in twelve fields (14%), cocona in eleven fields (12%), and a tree, capirona, in nine fields (10%). Twenty-two crops were found in just one field, and eleven crops in just two fields. No sweet potato was found in any fields, a crop recommended in the IIAP planting scripts.

Cropping Associations with Camu Camu:Discussion

Crop Compatability in a New Agroforestry System

Component interactions represent a critical aspect of agroforestry, both ecological and economic. The arrangement of components refers to the plant components of the agroforestry system (Nair 1993). Small farmers have been found to plant trees in extension projects if costs are minimal and their subsistence crops will not be affected (Park 1997). Of the more than 20 annual crops that were cultivated in association with camu camu, several were observed to be quite compatible with the trees, but many presented problems and farmers questioned if there were net gains from their efforts. With camu camu spaced two to three meters apart, space was at a premium in these fields. Manioc was considered to be an excellent crop to grow with camu camu, but for a limited time. The common knowledge was that after two or three years, either the manioc limited camu camu growth, or vice versa. Farmers explained that they indeed wanted to take advantage of the fertile soils and intercrop manioc on a permanent basis. Manioc, both an important subsistence and commercial crop, was still the most common crop associated with camu camu (Table 5-9). Many farmers said that if they had to start over again, they would have planted their camu camu at a distance of four or five meters between the trees, to better facilitate manioc.

Maize was the second most common crop associated with camu camu. Like manioc, maize is also equally important as a subsistence and commercial crop. Space requirements are less for this crop, but farmers explained that even for maize cultivation, they would have rather planted their camu camu with greater spacing between the trees. The same was true for melons, which can fetch high prices for farmers. It was clear that farmers wanted to exploit these fertile and easily worked floodplain fields in more intense ways with annual crops than they were currently doing with camu camu as the main tree component in their agroforestry systems.

The use of space in fields was reflected in the density of the annual crops in the fields. Maize had the highest mean density (3310 per ha). However, maize was usually found at lower densities, scattered around in open parts of the fields. Only in the Pucallpa area was maize consistently found to be planted in straight rows between the camu camu trees, and at higher than the mean density. Around Pucallpa, I observed that floodplain crops were often planted in rows, which was uncommon elsewhere in the study areas.

Cucumbers (“pepino”) were usually cropped on field edges and allowed to climb the camu camu trees. This was also observed with beans. The viny “caihua”plants also used the trees for support. Smaller annual crops such as tomatoes, peppers and cocona were preferred as the camu camu increased in size. Conversely, space-demanding annuals such as bananas and sugar cane were relatively rare, and usually occupied gaps in fields where camu camu was absent. This again raises the question about the density and future of camu camu in these fields.

Over two dozen tree crops were found to be cultivated in association with camu camu (Table 5-9) but farmers are just learning if their presence will be compatible with camu camu. As they learned by intercropping manioc, camu camu has above and below-ground space requirements that change over time and will only be understood through experimentation. For example, farmers explained that they were concerned about trees that would develop heavy canopies, such as “charichuelo” (*Rheedia* spp.). Except for those on field borders, these trees might soon be culled out from camu camu fields. Tree crops were usually found at very low densities in fields, and scattered about fields where space allowed tem to grow.

Most of the tree species growing in association with camu camu were planted or spared by farmers because they had three types of canopy growth that caused little interference with the sunlight required by camu camu *and* any associated annual crops:

1. Small canopies (e.g., papaya, vino huayo, guayaba, palms), 2. Light canopies (e.g., topa, huito, pashaco blanco), and 3: Canopies that developed after they were several meters off the ground (e.g., capirona, cedro, uvos). What remains to be seen over time is if there will be enough space below ground for these trees to be intercropped with camu camu. Some trees used for timber (e.g., cedro, lagarto caspi) might remain as the most permanent species in these fields, perhaps even outlasting the existence of the camu camu.

In Table 5-9, an asterisk marks crops that were usually spontaneous in the camu camu fields. However, some of the crops in the list are usually spontaneous in other agroecosystems. One thing I noticed was that on the floodplains, farmers more often weed out spontaneously regenerating species that would be spared for use in upland fields. The intensive nature of floodplain cropping compared to practices in the extensive uplands makes this understandable. Some of the tree crops found cultivated with camu camu that would nearly always have been spontaneous crops were in fact usually planted in camu camu fields. For example, aguaje and shimbillo are normally two trees that are found growing spontaneously on the floodplain because humans or animals have dispersed the seeds, and farmers decide to spare them when weeding. When I asked camu camu farmers about the origin of the trees, the majority said they were in fact planted, and that they had weeded out the spontaneous examples of these trees earlier because of the desire for a clear, entirely open space when starting the field. What we learn through this example is that different cropping combinations can render certain, valuable species incompatible at any time, given the pattern of land use. As the experiment with camu camu continues, farmers are just learning about its compatibility with other crops.

Learning the compatibility of camu camu with *tree crops* may require more time than with annual crops. More research is needed to determine what plants are most compatible with camu camu in these floodplain environments.

Weeds and Unwanted Plants

The most common weed in the fields was "gramalote" (*Olyra* spp.), which are broad blade grasses (Table 5-10). These grasses are barley sub-woody (Gentry 1993), very common along riversides, and hard to control. Controlling these grasses was very labor-intensive activity. However, the weeds that most concerned farmers were aggressive vines that would climb, smother, and often double over the young trees. These viny species (*Ipomoea* spp.*)* were collectively called "camotillo" or simply "sogas". In the Pucallpa area, a prominent weed not found elsewhere was "marco sacha" (*Ambrosia* spp.*)*, which requires a dry season to survive and may have come down from montane valleys in the Andes (Gentry 1993, Duke and Vasquez 1994).

If local farmers looked at the species listed in Tables 5-9 and 5-10, they probably would have argued over which of these "crops" were in fact weeds ("llierbas", "malesas"), meaning unwanted plants, and vice-versa. The value of a plant that a farmer finds in his garden is subjective, and related to the local availability and value of the plant. "Mullaca" or "bolsa mullaca" for example, is usually considered a weed (Table 5-10), except when they need to snack on the tasty fruits (Table 5-9). People might vigorously weed out young mullaca (*Physilis angulata*) plants from their fields during one season, but in another season allow them to grow up for food, and even sell them. Mullaca is a prime example of a low-value fruit that periodically serves as a convenient source of food and small amounts of money at times.

“Jergon sacha” is another plant that will be cut or spared by the machete, depending on farmer preferences. This plant has medicinal uses, especially for snake bite. “Retama”is a plant that farmers classified as a weed, but will be used for medicinal purposes. We have seen how suelda con suelda is a nasty weed in these fields, but it is also renowned for its medicinal properties.

Trees such as “pichirina” (*Vismia* spp.) and “rifari” (*Miconia* spp.) are protected in fields where sources of wood for construction and fuel are relatively scarce, but weeded out where they are abundant. In this study, they were nearly always weeded out, and therefore are listed as weeds in Table 5-10. Such preferences for crops and weeds also a matter of ethnicity and local uses, and more study is needed to understand preferences for foods in this region.

Crop Diversity and Component Assocations

The arrangement of components refers to the plant components of the agroforestry system (Nair 1993). The large number of species and their configurations in fields are special characteristics of agroforestry that distinguish it from conventional agriculture (Current et al. 1995). Camu camu cultivation was a new practice in a region with a tradition of agroforestry (Chapter 2), often described as a monoculture as opposed to an agroforestry system (Nebel 2001). However, *M. dubia* was found to be cultivated in association with a wide variety of crops (Table 5-9). Much like the upland agroforestry systems of the region, a few principal crops (camu camu, manioc, maize, melons, cocona, capirona) were identified in these fields (Coomes and Burt 1997). A favorite cropping combination was manioc, maize and camu camu. Findings here indicate that most camu

camu fields in this study were not monocultures of trees as Nebel (2001) describes them. Just thirty of the fields (34%) were monocultures of camu camu.

Where manioc was growing with camu camu (30 fields), half of these fields also contained maize. Manioc was much more densely planted in Iquitos area fields. The same was true for maize. These two crops were more densely planted in Iquitos area fields because these were young fields, where the camu camu was only one to two years old, and still with more space for manioc than in the other group of fields. Fields in the Iquitos area tended to be either monocultures or diverse in components, while crop diversity was spread more evenly across the other group of fields (Figure 5-4).

Fields not in the Iquitos area showed a slight preference for cultivating multiple annual crops with camu camu. Nine of these 43 fields (20.9%) contained three or more annuals, compared to six of 46 Iquitos area fields (13%). In the other group, the most common combination was maize with one other annual crop, found in thirteen fields, five of which were maize with watermelon. In the Iquitos area, manioc with another annual crop was most popular (eight fields). There was a more diverse mix of combinations, including bananas, and cocona was popular, found in nine of twenty-five fields with annual crops (36%). Watermelon, beans and tomatoes were most popular in the Pucallpa vicinity. Cucumber was most popular in camu camu fields near Jenaro Herrera, usually in combination with watermelon. These differences may also be explained by local cultural preferences for produce.

The data for tree crops displayed striking differences when comparing the two areas. In the group of Iquitos area fields, twenty tree crops were cultivated, with fruit trees most popular, compared to only four tree crops growing with camu camu in the other group of fields (capirona, huito, papaya, and andiroba). No field in that group had more than one tree crop growing with camu camu, while fifteen Iquitos area fields had one tree crop or more. Most of the trees in fields from the tree-poor group were capirona, planted as part of a previous project with the Comite de Reforestación (Chapter 3). These trees are used for construction needs or fuel. Clearly, farmers were adapting to local socioeconomic and biophysical conditions while developing new agroforestry systems with *M. dubia* as a key plant component.

Dynamics of Change in Cropping Patterns

Previous studies in the region have shown how farmer strategy emphasizes the cultivation of high value crops such as vegetables and melons on the fertile floodplains (Hiraoka 1986, 1989, Coomes1995). For example, rice is the most valuable crop on the floodplain (Chibnik 1994), and watermelons are especially valuable in the upper Tahuayo River (Coomes 1992). However, rice was not intercropped with camu camu, and only found near four camu camu fields. Despite its popularity in combination with camu camu, none of the camu camu fields in the upper Tahuayo were intercropped with watermelon. What might explain this? This is in part due to the "snap shot" nature of many studies in this area. Since the latter two studies, rice production has fallen on the floodplain due to socioeconomic and environmental factors. It helps to recall the findings from Chapter 3 that explain how villages in the Amazon River had given up most of their rice production where their mud flats had recently disappeared, and no credit was available. In the upper Tahuayo, the ribereños explained how flooding and disease had combined to drastically reduce watermelon cultivation from previous years. Quality seed was now very difficult to obtain for them to again begin farming watermelon.

This dissertation is no exception to the “snap shot” phenomena. For example, cocona was frequently associated with camu camu in the upper Tahuayo. This may seem surprising, because this crop is so often killed by floods before becoming productive. However, flood waters had not spilled over into these fields during 2001, allowing it to thrive for another season. If this study had taken place at a different time, it is likely that cocona would be rare in these fields. During the field inventories of 2001-2002, thirty of the fields (34%) were managed as monocultures of camu camu, but several farmers said they could have recently planted beans in these fields if they had the seeds, and would try to do so next season.

It was shown in Chapter 3 that in the Pucallpa vicinity, the local custom of not growing trees on the floodplain was a reason for people not wanting to plant camu camu in the first place. These lands are more intensively cropped, and the use of hoes and chemical inputs makes this preference understandable. With camu camu, tree cultivation is in fact made a return to parts of the floodplain near Pucallpa.

The findings discussed here, along with farmer reports, show that except for tree crops, cropping associations in these fields are subject to frequent changes. This highlights the need to examine camu camu fields in an area where trees other than camu camu are coveted for the fruits they provide to an especially strong market.

Tree Crops in Fields and the Iquitos Market

The city of Iquitos is not only the largest consumer market in the Peruvian Amazon, it is known as a market for an exceptionally diverse array of fruits (Vásquez and Gentry 1989, Padoch 1988b). This may lead us to assume that the Iquitos area fields, all located within one day in travel time to Iquitos, would contain far more fruit crops than the other group of fields in the study. However, the agroforestry systems near Iquitos that are well known as a source of these fruits are *upland*, rather than floodplain systems (Hiraoka 1986, Padoch and de Jong 1987, Coomes and Burt 1997). This gives us reason to be cautious with this assumption, and a need to reexamine findings from the field surveys.

Of the 21 fruit crops growing in fields with camu camu, 20 were found to be cultivated in Iquitos area fields, compared to just seven in the other fields. There were not only nearly three times as many fruit crops growing in the Iquitos area fields, but these crops were usually at a higher density than fruits in the other fields. Except for watermelon, the same fruits were grown in far more Iquitos area fields than other fields. For example, bananas were absent, and cocona was relatively rare in fields outside of the Iquitos area (Table 5-9).

The data for fruit trees also displayed striking differences between the two groups of fields. Only two camu camu fields outside of the Iquitos area contained additional fruit trees (papaya and huito). This compares to fourteen fields in the Iquitos area, where eleven of these fields contained multiple species of fruit trees. For example, shimbillo was found in eight fields versus none of the other fields. Charichuelo was in five fields, aguaje was in three, but these trees were also absent from the other group of fields. Papaya was found in six fields, huito was found in three, compared to just one of the other fields. These findings confirm the hypothesis that fruit crops are indeed more important in fields that are located within one day of Iquitos markets. There is a greater number of fruit crops, and especially fruit trees. The findings here are important because the agroforestry systems that provide most of the tree fruits for Iquitos were thought to be primarily *upland*, rather than floodplain systems. It also shows how many farmers have adapted to the demands of the PNCC and been able to cultivate camu camu in combination with the fruit crops they have traditionally marketed. Overall, the field inventories reveal the diverse forms of agriculture that were not apparent from the results of farmer interviews presented in Chapters 3 and 4. This highlights the need to utilize both research methods when attempting to understand agriculture in this region of the world.

Agroforestry and the Programa Nacional de Camu Camu

Agroforestry is the growing of trees and crops (and/or animals) together in interacting combinations. The exploitation of interactions between crop components is the key to success for all agroforestry systems. Most agroforestry systems aim to increase production of preferred commodities as well as productivity of the land (Nair 1993, Rao et al. 1998). Nebel (2001) describes the camu camu fields of the PNCC as monocultures, rather than agroforestry systems. We have already seen that since beginning camu camu cultivation, one-third of the farmers no longer practice multiple cropping in these fields, and camu camu is now the sole crop. Space limitations for multi-cropping in the PNCC field designs quickly became obvious, and manioc made an early exit as a crop component from many fields because it was not compatible with camu camu, either above or below ground. With the exception of papaya, tree crops in these fields were usually low in density. Four of the fields with tree crops besides camu camu contained just one tree. This is partly because camu camu, like most of the annual crops, needs direct sunlight. Farmers continually remarked about how the trees were increasing in size each year, and carefully monitored the performance of associated annual crops. As explained earlier, they often switched to less space-demanding crops and those that could climb the trees. This situation raises the question of whether camu camu cultivation on the floodplain can remain as an agroforestry system, or will these fields evolve into a mono-cropped, orchard system?

A look at the oldest fields helps to answer this question. Thirty-nine of the 89 fields (44%) were aged five years or older. Just over half of the fields (51%) contained multiple crops. Nine of these fields (23%) had four or more crops. These figures are in fact quite similar to the same characteristics analyzed over all fields (Figure 5-3). We might expect crop diversity to decrease with the age of the camu camu. However, there was no correlation between field age and crop diversity (r = .168), indicating that crop diversity in these fields has not decreased over time. Thus far, these findings indicate that many farmers are cultivating camu camu as part of an agroforestry system.

There is a need for caution here before drawing conclusions. Camu camu observed in two fields that were eight and 13 years old had spread to a point where the trees were touching one another. Both fields contained other tree crops, much greater in height (capirona and charichuelo). Cultivating most ground crops would have been very difficult. However, camu camu loses most of its leaves during the flood season, allowing quickly maturing climbing crops such as beans to be planted immediately after the flood recedes and begin growing in nearly full sunlight. It may be able to cultivate shade tolerant tubers such as sweet potatoes between the trees. This strategy has recently been promoted by some experts (Pinedo 2002). Near Pucallpa, farmers explained that they will continue to crop annuals in rows with camu camu, even as available space and light dwindles. As mentioned earlier, these farmers are experimenting with a form of alley cropping, and have skillfully changed their selections of annual crops to adapt to, rather than compete with, the new tree crop.

What is certain is that after the first few years, the intercropping of annuals with camu camu reaches a critical point where cropping combinations must be specifically adapted to space and light limitations in these fields. In the next phases of cultivation, we will learn which annual crops also find compatibility with the fairly light, but increasing canopy of camu camu. What also remains to be seen is which tree crops will avoid culling over the next few years as the camu camu matures and comes into full production. Spots in fields devoid of camu camu may eventually be filled in with camu camu, or still be used for coveted annual crops. Moreover, some trees (e.g., huito, timber) will remain as the most permanent species in these fields, perhaps even outlasting the lifespan of the camu camu itself. This study represents just a snap shot in time, and repeated surveys of these fields are necessary for us to better understand the nature of camu camu cultivation in agroforestry systems. At present, it is still too early to know exactly how the domestication of this small tree will affect floodplain agriculture. What the findings in this chapter demonstrate is that the domestication of this small tree is a process that is undergoing and will undergo several changes, and distinct phases of change in agricultural settings.

Environmental Implications of Camu Camu Domestication

Deforestation

Escaping poverty through agriculture often causes farmers to deforest greater amounts of land, and degrade the environment in a variety of ways (Wunder 2001). It was shown that just 10% of fields used for camu camu were cut from mature forests, and most fields were started in lands used continually for agriculture. Even though rural communities were under strong pressure from extension agencies to plant camu camu, significant deforestation did not occur because of the PNCC. This also gives credence to the notion that the adoption of agroforestry systems can provide an alternative to deforestation (Current et al. 1995). The findings presented in this chapter represent the initial deforestation on the floodplain landscapes associated with the PNCC. As fields mature, farmers must look to other land to cultivate their especially important crops of manioc and maize, which could lead to increased clearing of forested lands. If a new boom in camu camu planting occurs, we may see extensive clearing of mature forests.

Soil Erosion

It is difficult to determine if the cultivation of camu camu might increase or decrease soil erosion along the floodplain. Multi-story tree gardens are the most likely agroforestry systems to control erosion (Nair 1993). As most lands where camu camu was planted were already cleared, the main concern over erosion might be for the small portion of lands where mature forest and older fallows were used. However, tall grasses such as gramalote may be better at retaining soils than trees. On the floodplain, all lands are subject to varying degrees of both soil erosion and deposition. Obviously, studies are needed to determine if camu camu cultivation could contribute to soil conservation. With most fields so close to the rivers, it seems likely that all but the most short-term events concerning soil are dictated by the rivers.

Aquatic Fauna

The need to conserve floodplain forests is especially important for the fruit-eating fish of Amazonia (Araujo-Lima and Goulding 1997). In camu camu fields, four tree species were spared for use as fish bait (Table 5-9), and most of the other trees cultivated for human use in these agroforestry systems have fruits and seeds that are also consumed by fish. Camu camu itself is an important fruit in the diet of the valuable "gamitana" (*Colossoma macropomum*) and several other fish of commercial importance (Chapter 6).

According to farmers, the addition of camu camu has probably attracted *more* fish to their fields during flood season. Many farmers fish in their fields, and run gill nets in between the young trees, just as people do in wild stands of camu camu. Where the trees had fruited, some of these farmers have insisted that gamitana are coming to their fields because of the camu camu, although I could not verify this. Still, this makes for an interesting situation. While the camu camu fruits will be harvested for sale, many will fall into the water, and the presence of other trees in the fields will also attract fish. Thus, the PNCC appears to be creating "fish orchards" as described by Araujo-Lima and Goulding (1997), but with humans counting on exploiting most of the fruit harvest.

I observed that most of the camu camu fields were not flooded when fruiting, but fruiting in cultivated camu is spread over much of the year, including months of high water. In terms of ecological value, the camu camu fields may not provide the equivalent habitat of a floodplain forest for fish, but they have and will be utilized as fishing grounds.

Unintentional Effects of Camu Camu Domestication

Aside from the alarm over deforestation of tropical landscapes, there is a need for concern about the unintentional spread of valuable tree species across extensively used landscapes (Unruh 1994). Once established, will these camu camu fields begin to disperse seeds that will spread this species across floodplain landscapes? Should we be concerned about this possibility?

One factor may mitigate, or dilute the effects of any spread of camu camu from these fields: Over half of these fields were located where wild *M. dubia* already exists, and is fruiting, and findings from Chapter 3 indicate that extension agencies were most active in these areas. On the other hand, what about camu camu planted in the vicinity of Pucallpa, where *M. dubia* does not exist in the wild? This will indeed need to be studied. We can assume that many fish here may be consuming and dispersing the fruit for the first time. Finally, it remains to be seen if the cultivation of camu camu along white water rivers such as the Amazon and Ucayali will allow this species to disperse and establish itself in white water environments.

This scenario also raises questions about pollination. Like most trees, *M. dubia* is an outbreeding species, meaning it can transfer the pollen from one individual to the stigma of another of a different genotype[6]. With fields containing a mixture of planting stock from all over the region, we can assume that a large number of crosses between different genotypes will occur within and between fields. Findings discussed earlier in this chapter certainly point in this direction. At the same time, trees in almost half of these fields will most likely cross with wild camu camu, which in some cases is located adjacent to fields or less than 100 meters away. What is not known is if this can take place between *M. dubia* and the other larger tree species of *Myrciaria,* but scientists at IIAP-Pucallpa doubt that this is common[7].

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[6] Mario Pinedo, IIAP-Iquitos, personal communication, 2002.

[7] Raul Anguiz, IIAP-Pucallpa, personal communication, 2001.

Pests and Disease

The introduction of new plant species to existing agricultural systems may bring an increased risk of pest and disease outbreaks (Schroth et al. 2000). Two important tree crops, cacao and rubber, made an early exit from Amazonian environments because their extensive cultivation had increased problems with disease (Smith et al. 1992). With camu camu, findings from this chapter show that pests and diseases are frequent in the fields, and can occur in local concentrations. Other crops of the *Myrtaceae* family in these fields, such as arazá and guayába, may be especially vulnerable to these maladies, just as camu camu may succumb to theirs. Clements (1993) warns that when fruits from the forest undergo domestication, such changes are to be expected. These changes may not only affect cultivated camu camu, but also wild stands of the trees.

Pests and diseases endemic to wild stands of camu camu might not yet be expected in Pucallpa area fields, but this must be monitored. If Clement (1993) is indeed correct in his warning, pests and diseases found in wild camu camu could soon appear in the Pucallpa area, out of their natural habitat. A true test of this may lie with the insect pest *Conotracheius dubiae* naturally found in wild camu camu fruits. As with wild camu camu, this species was not found or reported to exist in fields near Pucallpa.

The nature and incidence of pests and diseases for camu camu could quickly change especially, where wild camu camu is growing in the vicinity of these fields. Meanwhile, IIAP has identified 64 potential insect pests for camu camu. Currently only a few are known to be harmful (Delgado and Couturier 2002). Still, camu camu cultivation is in its early stages, and there is no reason to believe that it is immune to some of the more classic problems that other domesticated crops in Amazonia have suffered. This could conceivably give rise to what Homma (1992) will again designate as yet another boom and bust cycle for Amazonia.

Conclusions and Recommendations

Myrciaria dubia probably experienced relatively little selective pressure from humans until the initiation of the PNCC thrust camu camu onto the agricultural landscape of the Peruvian Amazon. The urgent and extensive domestication of camu camu by the PNCC may have promoted the genetic diversity of camu camu fields. Still, our knowledge of the ethnobotany of *M. dubia* is very limited, and more research is needed to document the human use of this widespread riverine fruit tree.

Cultivated camu camu trees exhibit considerable variations in their phenology and morphology. The fruiting period appears to be more spread throughout the year, and two fruiting cycles can occur. More time is needed in order to understand the response and adaptation of camu camu to agricultural environments. The soil requirements of camu camu have received little attention, and were not researched in this dissertation. More research is needed to understand how *M. dubia* performs in different edaphic conditions.

Most farmers attempted to follow the PNCC planting scripts for camu camu within their fields as far as the spacing of the trees, but over 80% did not adhere to the program recommendations when selecting lands for their fields. Few fields were located on the recommended restingas, while the preferred landform for cultivation was in the lowest lands. A typical camu camu field was located just 50 meters from a river, and in danger of erosion or sedimentation problems. The permanence of these fields is in question, even within the next few years.

Camu camu was usually planted with a spacing to facilitate the interplanting of manioc and other crops, rather than at a density to obtain maximum fruit yields per unit area. A typical field contained 1200 trees per hectare, close to the recommended density of 1111 trees per hectare for intercropping camu camu with manioc.

Most of the camu camu fields were less than one hectare in size, with some of the smallest fields started by farmers on their own initiative without the help of extension agencies. In these fields farmers often tried to mimic the spacing of young camu camu in the wild. This is yet another example of farmer experimentation, and again shows that interest in cultivating camu camu may continue, but not according to extension recommendations.

Iquitos area fields were significantly smaller in size, closer to riversides, and located closer homes than fields located outside of this area. These fields also had the highest diversity of crop components. Farmers in this area were willing to experiment with the new crop on a smaller scale and closer to home, much like a home garden.

Fields outside of the Iquitos area tended to be larger, more orderly in configuration, and were maintained in significantly better condition than Iquitos area fields. The need to maintain claims to land and a strong market for cultivated camu camu in Pucallpa contributes to these characteristics, as well as the more intensive land use practices found near this city.

Camu camu trees in most fields were infested with diseases and insect pests. Some of these maladies were felt to damage the trees, others had no obvious effect on tree growth. Farmers believed that a shoot borer insect was actually improving fruit production. More research is needed to determine whether insects and diseases can be considered pests or innocuous with their presence. Regardless of the level of pests and diseases in their fields, farmers felt that only the parasitic climbing plant *Moradendron* spp. did any damage to the trees.

Clear patterns for the presence of diseases and pests across camu camu fields existed in the study areas with varying levels of infestations. Some patterns were only noticeable at the regional level. Local patterns such as clustering of pests and disease were also exhibited at the regional scale. Flood waters appear to have suppressed these infestations, and mature forest environments may have something to do with the low incidence of maladies in some fields.

Most camu camu fields in this study were not monocultures of trees, contradicting observations from previous studies. Fifty-five crops were cultivated in association with camu camu. Twenty-one were annual crops, and 34 were perennials. However, just a few principal crops were identified in these fields. Up to 10 crops per field were cultivated in association with camu camu, but slightly more than one-third of these fields consisted solely of camu camu trees.

Across all fields, manioc was the most common crop associated with camu camu. Maize was the second most common crop associated with camu camu, and had the highest mean density of any crop in these fields. A favorite cropping combination was manioc, maize and camu camu.

Space was at a premium in these fields, especially to cultivate manioc, which competes with camu camu for space above and below ground. Farmers were pondering ways to better facilitate manioc cultivation in these fields.

Differences between fields in cropping references were due to different market demands and may also be explained by cultural preferences for produce. Such preferences for crops and weeds also a matter of ethnicity and local uses, and more study is needed to understand preferences for foods in this region. This includes learning why plant species considered weeds by some farmers were cultivated by others. There is a need to work closely with farmers across the region in order to understand what plants are truly compatible with camu camu; in either short or long-term presence in these fields.

Over two dozen tree crops were found to be cultivated in association with camu camu but farmers are just learning if their presence will be compatible with camu camu. As they learned by intercropping manioc, camu camu has above and below-ground space requirements that change over time and will only be understood through experimentation. Most of the tree species growing in association with camu camu had three types of canopy growth that caused little interference with the sunlight required by camu camu *and* any associated annual crops. What remains to be seen over time is if there will be enough space below ground for these trees to be intercropped with camu camu.

Analysis of crop diversity across fields confirmed the hypothesis that fruit crops are indeed more important in fields that are located within one day of Iquitos markets. There is a greater number of fruit crops, and especially fruit trees. This reveals that it is not only upland, but floodplain agroforestry systems that provide a diverse number of fruits for the Iquitos market. With camu camu cultivation, even more fruit will soon come from this environment. It also shows how many farmers have adapted to the demands of the PNCC and been able to cultivate camu camu in combination with the fruit crops they have traditionally marketed.

Different cropping combinations can render certain, valuable species incompatible at any time, given the pattern of land use. As the experiment with camu camu continues, farmers are just learning about its compatibility with other crops. The same is true for its tolerance to weeds. The most common weeds in the fields were broad blade grasses, but it was viney weeds which did the most harm to the trees. More research is needed to determine what plant species are most compatible with camu camu in these floodplain environments.

Except for tree crops, cropping associations in these fields are subject to very frequent changes. After the first few years, the intercropping of annuals with camu camu reaches a critical point where cropping combinations must be specifically adapted to space and light limitations in these fields. We might expect crop diversity to decrease with the age of the camu camu. Most farmers were still cultivating camu camu as part of an agroforestry system. There was no correlation between field age and crop diversity, indicating thus far that crop diversity in these fields does not decrease over time. However, there is a need for caution here before drawing conclusions. The oldest camu camu in fields was observed to have spread to a point where the tree canopies were touching. More research on the evolution of these agroforestry configurations over time is needed. Meanwhile, planners must recognize the need to retain agroforestry systems and their multiple harvests on n these valuable, seasonally flooded lands. Farmers will need to continue manioc and maize cultivation in these fields, in addition to other, less space-demanding annuals. Tree crops must have compatible canopy types for these cropping associations. It is advisable that camu camu be planted with a spacing of at least three meters or greater between the trees to lessen dependence on camu camu fruit harvests and better satisfy farmer needs. The more successful agroforestry configurations described in this chapter could serve as new models for future camu camu programs.

Camu camu cultivation has not only changed cropping patterns on the floodplain, it has changed the biophysical environment. The PNCC has initially done little to promote deforestation. More than half of the fields were started on lands that were already occupied by cultivated fields, while only one out of 10 fields was cut from mature forest. The program has helped tree farming return to parts of the floodplain, such as in the vicinity of Pucallpa. However, as fields mature, farmers must look to other land to cultivate their especially important crops of manioc and maize, which could lead to increased clearing of forested lands. If a new round of camu camu planting begins, we may see much more use of mature forest. Meanwhile, the PNCC appears to have created improved habitat for some fish species.

There may be unintentional effects of camu camu domestication such as the transfer of pests and diseases between wild camu camu or other crops. This may bring an increased risk of pest and disease outbreaks. As camu camu is now cultivated in very close proximity to wild stands of the trees, we should also expect the transfer of genetic traits between wild and domesticated camu camu.

Floodplain farmers of the Peruvian Amazon have adapted to circumstances of the Programa Nacional de Camu Camu in their own unique ways. Thanks to their patience and expertise, planners can learn how to maximize production and income from these new agroforestry systems. We have learned that many farmers have been able to cultivate camu camu in combination with a diverse array of crops they have traditionally marketed and subsisted on, and how they have abandoned inflexible planting scripts and adjusted farming strategies in order to do so. Such dynamics of change in cropping patterns are difficult to show in a short study. This dissertation provides only a snapshot of some of the biophysical and socioeconomic processes at work as camu camu undergoes domestication in Peru. Findings presented here may help planners to improve their strategies for cultivating camu camu with small farmers, while drawing attention to the environmental implications of this new form of land use on the floodplain.

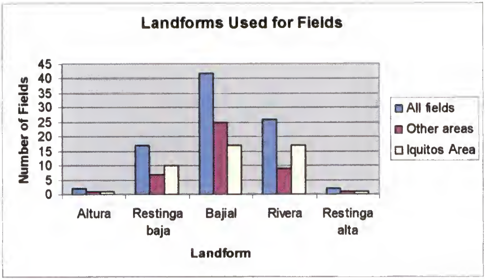

Figure 5-1. Landforms used for camu camu fields.

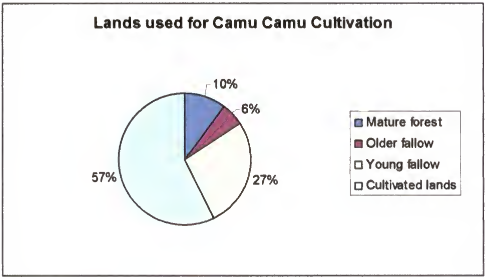

Figure 5-2. Lands used for camu camu cultivation.

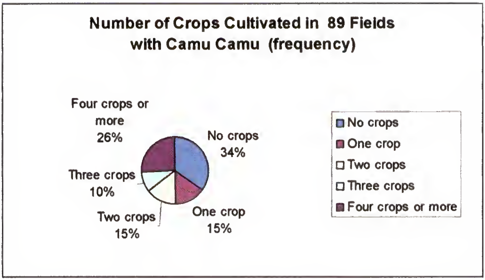

Figure 5-3. Number of crops cultivated in fields with camu camu.

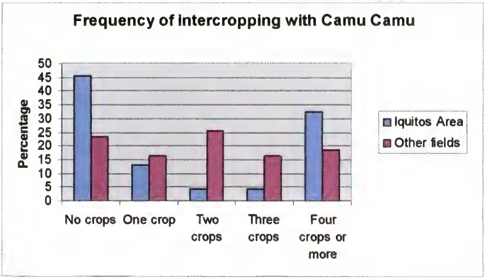

Figure 5-4 Frequency of intercropping with camu camu between the two groups of fields.

Distance to river	All fields (n = 89)	Iquitos area (n = 46)	Non-Iquitos area (n = 43)
Mean distance (m)	140.6	101.6	184.7
Median distance	50	25	100
Std. deviation	198.028	163.907	223.455
Range in distance	1 to 700	1 to 500	1 to 700

Table 5-1. Distance from nearest field edge to rivers.

Distance to homes	All fields (n = 89)	Iquitos area	Non-Iquitos area
Mean travel time (minutes)	11.809	6.89	17.07
Median travel time	10	5	15
Std. deviation	11.858	8.965	12.397
Range in time	1 to 50	1 to 50	1 to 45

Table 5-2. Travel time from farmers' homes to camu camu fields.

Sample	All fields (n = 89)	Iquitos area (n = 46)	Non-Iquitos area (n = 43)
Mean field area (ha)	.67	.45	.91
Median	.45	.31	1
Std. deviation	.6	.385	.697
Range in field area	.05 - 3	.05 - 2	.05 - 3

Table 5-3. Size of fields planted with camu camu.

Sample	All fields (n = 89)	Iquitos area (n = 46)	Non-Iquitos area (n = 43)
Mean density ($100m^2$)	15.52	17.19	13.72
Median density	12	12	12
Std. deviation	11.825	14.691	7.439
Range in density	1 - 84	1 - 84	3 - 40

Table 5.4. Density of camu camu in fields, per $100m^2$.

Fields	All fields (n = 89)	Iquitos area fields (n = 46)	Non-Iquitos area (n = 43)
Mean age of camu camu in years	3.81	3.7	3.93
Median age	4	4	4
Std. deviation	1.906	2.249	1.473
Range in age	1 - 13	1 - 13	2 - 8

Table 5-5 Age of camu camu in fields.

Fields	All fields (n = 89)	Iquitos area fields (n = 46)	Non-Iquitos area (n = 43)
Mean condition	2.8	2.57	3.05
Median condition	3	3	3
Std. deviation	1.035	1.047	.975
Range	1 - 4	1 - 4	1 - 4

Table 5-6. Field survey conditions.

Pest or disease	Percentage of fields affected	Percentage of camu camu in those fields with infestations
Tuthillia cognata	51.7	48.7
Fumago sp.	33.7	43.8
Moradendron spp.	14.6	42.1
Xylosandrus compactus	13.4	11.5
Conotracheius dubiae	1.1	12.5
Cattle, people	5.6	22.2

Table 5-7. Pests and diseases found in ten by ten meter sample plots.

Pest or disease	Percentage of fields affected Iquitos area	Percentage of CC in those fields with infestations	Percentage of fields affected Non-Iquitos area	Percentage of CC in those fields with infestations
Tuthillia cognata	34.8	39.2	69.7	55.3
Fumago sp.	40	43.4	30.2	44.3
Moradendron spp.	23.9	42.6	4.7	33.3
Xylosandrus compactus	10.9	25	16.3	26.1
Conotracheius dubiae	2.2	12.5	0	0
Cattle, people	2.2	36.3	6.9	12.8

Table 5-8. Comparison of infestations between study areas.

Vernacular name	Scientific name	Main product	Density	No fields	Iquitos area	No fields	Non-Iquitos	No fields
Maíz	*Zea mays*	Grain	33.1	22	46.9	7	26.6	15
Yuca	*Manihot esculenta*	Tuber	24.8	30	60.8	9	9.4	21
Camu camu	*Myrciaria dubia*	Fruit	15.5	89	17.2	46	13.7	43
Sandia, sandília	*Citrullus lanatus*	Fruit	5.25	12	2	4	5.5	10
Cocona	*Solanum sessiliflorum*	Fruit	2.9	11	9	2.6	4	2
Capirona	*Calycophyllum* spp.	Fuel	1.1	9	1	2	1.1	7
Shimbillo	*Inga* spp.	Fruit	1.4	8	1.4	8		0
Pepino	*Cucumis anguria*	Vegetable	6	7	6	2	6	5
Frijol	*Phaseolus* spp.	Bean	18	6	8	2	23	4
Plátanos	*Musa* spp.	Fruit	2.7	6	2.7	6		0
Papaya	*Carica papaya*	Fruit	1.3	6	5	1.3	1	1
Caihua	*Cyclanthera pedata*	Vegetable	13.8	5	3	3	30	2
Melon, melon dulce	*Cucumis melo*	Fruit	5.4	5	3	2	7	3
Charichuelo*	*Rheedia* spp.	Fruit	2	5	2	5		0
Chiclayo	*Vigna unguiculata*	Bean	22	4	24	3	16	1
Tomate	*Solanum lycopersicum*	Vegetable	5.5	4	2	3	16	1
Guava	*Inga edulis*	Fruit	1.8	4	1.8	4		0
Ají	*Capsicum* spp.	Condiment	3	3	1.5	2	6	1
Aguaje	*Mauritia flexuosa*	Fruit	2.7	3	2.7	3		0
Caña	*Saccharum officinarum*	Juice	2.6	3	3	2	2	1
Huito*	*Genipa americana*	Fruit	2	3	2.5	2	1	1
Huingo	*Crescentia cujete*	Crafts	1.3	3	1.3	3		0
Bijáo*	*Ischnosiphon* spp.	Wrapper	1	3	1	3		0
Sacha culantro	*Eryngium foetidum*	Condiment	21.5	2	40	1	3	1
Zapallo	*Cucurbita* spp.	Vegetable	14.5	2		0	14.5	2
Mullaca*	*Physalis angulata*	Fruit	13	2	20	1	6	1
Jergon sacha*	*Dracontium loretense*	Medicine	9	2	9	2		0
Maní	*Arachis hypogaea*	Legume	6	2	6	2		0
Shahuinto	*Myrciaria* spp.	Fruit	4.7	2	4.7	2		0
Parinari, supay ocote	*Couepia subcordata*	Fruit	4	2	4	2		0
Cedro*	*Cedrela* spp.	Wood	1	2	1	2		0
Amacísa	*Erythrina* spp.	Medicine	1	2	1	2		0
Huasaí	*Euterpe precatoria*	Palm heart	1	2	1	2		0
Vino huayo*	*Coccoloba* sp.	Fish bait	1	2	1	2		0
Albaca, sacha albaca	*Lantana camara*	Medicine	15	1	15	1		0
Malva	*Malva* sp.	Medicine	4	1	4	1		0
Topa*	*Ochroma* spp.	Wood	4	1	4	1		0
Piña	*Ananas comosus*	Fruit	2	1		0	2	1
Andiroba	*Carapa* sp.	Wood	2	1		0	2	1
Lagarto caspi*	*Callyophyllum* sp.	Wood	1	1		0	1	1
Shiringilla*	*Micrandra* sp.	Fish bait	1	1		0	1	1
Tamara*	*Crataeva* sp.	Fish bait	1	1	1	1		0
Pichana	*Sida* sp.	Brooms	1	1	1	1		0
Biscocho huayo*	*?*	Nut	1	1	1	1		0
Sinamillo, bacabillo	*Oenocarpus* sp.	Fruit	1	1	1	1		0
Guayaba	*Psidium guajava*	Fruit	1	1	1	1		0
Caimito	*Pouteria caimito*	Fruit	1	1	1	1		0
Uvilla	*Poourouma cecropiifolia*	Fruit	1	1	1	1		0
Pijuayo	*Bactris gasipaes*	Fruit	1	1	1	1		0
Arazá, guayaba brasilera	*Eugenia stipitata*	Fruit	1	1	1	1		0
Punga	*Pseudobombax* sp.	Wood	1	1	1	1		0
Pashaco blanco*	*Parkia* sp.	Wood	1	1	1	1		0
Palometa huayo*	*Alchornea* sp.	Fish bait	1	1	1	1		0
Cuchillo vaina*	*?*	Medicine	1	1	1	1		0
Uvos	*Spondias mombin*	Fruit	1	1	1	1		0

Table 5-9. Crops found to be cultivated in association with camu camu.

Family	Species*	Vernacular name	Common Uses**
Asteraceae	*Pollalesta* spp.	Ocuera	
	Ambrosia spp.	Marco sacha	
Bignoniaceae	*Jacaranda* spp.	Huamansamana	W
Guttifererae	*Vismia* spp.	Pichirina	W, Fr, M
Caesalpinioideae	*Caesalpinia* spp.	Pashaquilla, pashaco	
Convolvulaceae	*Ipomoea* spp.	Camotillo, sogas	
Leguminosae/ Mimosoideae	*Inga* spp.	Shimbillo	F, Fr
Leguminosae	*Calopogonium* spp.	Mata-pasto, kudzu	
Loranthaceae	*Phoradendron* spp.	Suelda con suelda	M
Polygonaceae	*Coccoloba* spp.	Vino huayo	B, d
Papilionoideae	*Vigna* sp.	Mata-pasto, kudzu	
Marantaceae	*Ischnosiphon* spp.	Sacha bijao	food wrap
Melastomaceae	*Bellucia* spp.	Níspero, sacha nispero	m
	Miconia spp.	Rifari	W,fr
Moraceae	*Cecropia* spp.	Cetico	m
	Olmedia sp.	Llanchama	m
Musaceae	*Heliconia* spp.	Plátanillo	
Poaceae	*Andropogon bicornis*	Cola de caballo	m
	Olyra spp.	Gramalote	
Piperaceae	*Pothomorphe* spp.	(Hoja de) Santa Maria	food wrap, m
Solanaceae	*Physalis angulata*	Bolsa mullaca	F
Vitaceae	*Cissus sicyoides*	Zapo huasca	M

Table 5-10. Partial list of common "weed" species and their uses.

* Species from Gentry (1993), Paitán (1997)

** F= food or condiment uses, M=medicinal, D=dye, W= wood for construction or crafts, B=bait, Fr=firewood or charcoal

Upper case letters mean use is common, lower case means use is less common.

CHAPTER 6

ENVIRONMENTAL IMPLICATIONS OF CAMU CAMU HARVESTS

Introduction

The predatory extraction of non-timber forest resources (NTFRs) has historically caused such great damage to plant species at the local and regional level that entire industries have collapsed due to the destruction of their natural resource base. Even when harvests are non-predatory in nature, persistent, intense harvests can negatively affect the productivity and regeneration of species supplying international markets (Homma 1992, 1996). Recent studies demonstrate that this durable pattern of destructive extraction for NTFRs still persists in northeastern Peru (Padoch 1988b, Vásquez and Gentry 1989, Alvarez 1990, Padoch 1992, Mejia and Alvarez 1998).

The productivity and economic potential of camu camu forests is exceptionally high for a NTFR in Amazonia (Peters et al. 1989, Villachica 1996). Despite years of studies demonstrating that *Myrciaria dubia* is a highly productive fruit tree in the wild (Calzada 1980, Peters and Hammond 1990, Peters 1996, Vásquez 2000, IIAP 2001), little is known about the ability of the wild trees to withstand intense harvest pressure. Peters and Hammond (1990) conducted one of the few known studies on the regeneration of wild camu camu stands commercially exploited by people on an annual basis, the camu camu of Supay-Sahua Cocha, near the town of Jenaro Herrera. Results of the study suggested that these harvests had no effect on the natural regeneration of camu camu (ibid.). However, this study was conducted well before the boom in the camu camu market, when the fruit was exploited for a limited regional market, rather than to supply a larger export industry.

During my visits to the Iquitos markets I observed a preponderance of vendors hawking bags of unripe camu camu fruits. It was reasonable to assume that most of the ripe fruit was going straight to local processing plants of the new industry, but also surprising to see the enormous amount of green, immature fruit in local markets. I quickly learned that this was a severe problem– the harvesting of immature fruits unsuitable for industry (and of poor quality and taste for local consumption). With all the enthusiasm generated over the Programa Nacional de Camu Camu (PNCC), few, if any people involved could explain how the cultivation program might help relieve harvest pressures on wild stands.

Camu camu fruit is usually picked by people from boats, which reduces damage that might otherwise occur to these forests when they are not submerged (Peters and Hammond 1990). My first examinations of wild stands during this study revealed a human impact I had never seen in camu camu before: Many of the trees had a large number of twisted, broken and dead branches, obviously as a result of intense harvests (Figure 6-1). The prevailing notion then was that wild stands that were not claimed by communities were subject to the most abusive harvests, and these were stands located close to Iquitos, where local competition for the fruits was fierce. However, an experienced INADE official told me that the camu camu stands in the very distant Putumayo River looked as if they "had been run over by a car".[1]

These reports, along with my initial observations, made it important to examine the new pressures on wild camu camu created by the nascent industry. How were camu

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[1] Luis Moya, Regional Director, INADE, personal communication, 2001.

camu forests being damaged by the recent harvests, and what explains the nature of this damage? Is camu camu located close to Iquitos suffering more damage than more distant forests? The research concentrates on the damage found from recent harvests, but it also questions whether local communities are attempting to manage harvests. Answering these questions can help reveal the intensity and character of these harvests, and determine if local communities might contribute to the conservation of these valuable forests. The way these forces interact, and their patterns of interaction are discussed. The environmental implications of these harvests are also presented.

Methods

Damages censuses were conducted in order to assess the physical damage done by harvests to five different camu camu forests. These were located along the Nanay and Tahuayo Rivers, and in lakes just off the Ucayali and the Putumayo rivers (Chapter 1). The Pucallpa study area lies out of the natural range of *Myrciaria dubia*. Of the two camu camu forests were in lakes near the Putumayo River; one was on the Colombian side of the river (Tinta Cocha) , and Cedro Cocha was on the Peruvian side (Figure 6-2).

To examine the condition of harvested wild stands of camu camu, a census was conducted with a random sample of 150 plots from each of the five forests. Camu camu resembles large bushes, and exist in clumps and dense stands. The plots were five meters long and two meters deep, which corresponds to what a person can readily observe when positioned in front of or within a stand of the trees. In each plot, I recorded the damage to the trees and age of the trees. The portion of trees with harvest damage (such as broken, dead or cut branches) was observed. The level of damage was ranked into four categories: no damage, light, medium, and heavy damage. “Heavy” means major damage to tree, with a main trunk or two main branches broken off, "medium" damage was where one main branch broken, while light damage meant that only the smallest branches had been broken. I enlisted the aid of local experts to help me define the categories and limit my own personal bias.

There were three age categories for the trees: young, middle, and mature. All trees classified as mature had a diameter at breast height (DBH) of at least 10 centimeters, measured with a diameter tape. Local camu camu experts were trained in the method and at least two people accompanied me when conducting surveys.

Most of the censuses were done from a boat that moved slowly through the stands of trees. We also walked on foot at times. After a random point was reached, the boat would move slowly along, and stop at five spots located about ten to twenty meters apart to record damage level and age in each plot. A GPS unit was used to record the location of each of the thirty points.

Socioeconomic data was collected through participatory observation during harvest seasons. I helped harvest camu camu, and attended community meetings concerned with these harvests. I also conducted extensive informal interviews with rural inhabitants, camu camu buyers, factory managers and their intermediaries, and investors in the business. Government officials and researchers from several institutions were interviewed. An important purpose of these interviews was to determine the frequencies and locations of camu camu harvests both for industry and for traditional markets in Iquitos.

Results

Overall, two-thirds of the census plots (67%) were undamaged or suffered only light damage. Medium damage was observed in 21% of the plots, and 12% were observed with heavy damage (Figure 6-3). When comparing the levels of damage between the different camu camu forests, the frequency of damage varied considerably. Tinta Cocha, on the Colombian side of the Putumayo River, had the most extensive and severe damage. Only 9% of the census plots there were undamaged, and more than half (57%) exhibited medium or heavy damage. Supay-Sahua Cocha had the second highest frequency of heavy and medium damage, followed by Cedro Cocha. Such damage was much less frequent in the Nanay River, and Tahuayo River camu camu forests had the least incidence of medium and heavy damage. Heavy or medium damage was observed in 23% of the survey plots on the Nanay River, and just 9% on the Tahuayo River (Table 6-1).

Overall, slightly more than one-quarter of the trees in the samples plots (27%) were young, 41% were middle-aged, and 32% were mature (Figure 6-4). The Supay-Sahua Cocha and Tahuayo River camu camu forests had the highest percentage of mature trees, with 45% for both samples. More than a third of the trees in the Tinta Cocha plots were mature (37%). Mature trees were much less frequent in Cedro Cocha and even less frequent in the Nanay River (Table 6-2). While conducting the forest surveys, it appeared that the variables of damage and age were not independent of one another.
This is because older trees were often observed to suffer greater damage than younger trees. A Chi-squared test revealed that overall, the level of damage was indeed dependent upon the age of the trees (Chi-squared = 252.56, df = 6, $p < .001$).

Discussion

Assessing Qualitative Variables: Damage and Age Classes.

Measuring physical damage observed in tropical tree species is a challenging task, and the development of formal methods to assess this type of harvest damage is needed.[2] There is no way to quantitatively measure the damage to the trees; we can only qualitatively rank it. The same applies for age, as I could not determine the age of the trees in years. Still, it is useful to covert ordinal scales to quantitative values because each level has a greater or smaller magnitude of the characteristic than another level (Agresti and Finlay 1997). In this case, damage levels were assigned scores of one, two, three and four; from no damage (1) to heavy damage (4). Age classes were assigned scores of one through three, from young (one) to mature (three).

We can take advantage of the quantitative nature of the ordinal scales and conduct statistical tests, but with caution. There is an element of bias here, and a limit to the extent of this testing. In this case the Pearson Chi-squared test is acceptable[3]. This test is useful because it enhances our ability to explain the observed phenomenon in camu camu.

Harvest Conditions and Damage to Camu Camu

Heavy and medium damage to the trees was observed much more frequently in lakes off the Putumayo and Ucayali rivers than in the Tahuayo and Nanay rivers (Table 6-1). If we combine the samples, medium damage was observed in more than one quarter of these plots (27%) with heavy damage in 17%, compared to just 11% and 4% for the combined Tahuayo and Nanay samples. These forests with greater damage were older than the Nanay forests , but they were not any older than those of the Tahuayo River. What else might explain these differences?

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[2] Dr. Jack Putz, Department of Botany, University of Florida, personal communication 2001.

[3] Dr. Timothy Fik, Department of Geography, personal communication, 2001.

It appears that damage to camu camu stands where processing barges or large boats had worked was much greater than in areas where local people had to send the fruit to processors or markets themselves. Furthermore, the presence of these camu camu buyers arriving with cash in a local area set off a stampede of people to harvest the fruit causing much more than normal, minimal harvest damage to the trees. Still, more frequent visits of these large operations did not necessarily result in more damage. For example, Supay-Sahua Cocha had been visited by processing barges for at least five harvest seasons, more than any other area surveyed. Despite having a higher portion of mature trees than Tinta Cocha, damage was more extensive and severe to trees in the Colombian lake.

Another comparison helps to further illuminate the matter. For example, in the Putumayo River, after two years of extensive harvests and one minor harvest, damage to the trees was much more frequent and heavy than in the Tahuayo River, which had experienced seven consecutive years of harvests (Table 6-1). The Tahuayo had experienced two visits by buyers with large boats, but harvest were not on the scale of the Tinta Cocha harvests, where most fruits were sent to local processors in El Estrecho. Another key difference existed between the harvests in these two different areas; small canoes were used to efficiently harvest the fruits in the Tahuayo, while in Tinta Cocha the people did not have canoes, and had to harvest the fruits from ten to twenty meter long wooden boats. This forced the people to use harvest methods that did exceptional damage to the trees.

Explaining Relationships Between Harvest Methods, Damage, and Access to Fruit

The standard method to harvest camu camu is to sit or stand in a canoe and pick the fruits as quickly as possible. When the fruits are too high, the people often employ a type of hook cut from a tree branch called a "gancho", which allows them to reach up and pull the high, flexible branches down to pick off the fruits. Care must be taken, as the fruits will sink if they fall into the water. A preferred method is to have one adult and one child together, picking from each end of the canoe. When fruits are exceptionally high, young children will scale the larger branches of the tree to obtain them. The larger branches are not only older, but the most brittle, often breaking if climbed. This explains how much of the major damage was done to the trees. The people of the Tahuayo River and the Jenaro Herrera area exhibit great skill at harvesting fruits quickly and efficiently, and when the trees are full of fruit, some canoe teams can harvest sixty to one hundred kilos of fruit per day (Chapter 7).

Compare this situation to that of the Putumayo River, and Tinta Cocha in particular. Nearly all the harvesters are Peruvians , who come from the nearby town of El Estrecho (Figure 6-2). Relatively few of them have canoes, as the current is dangerous in the river and most people walk to their gardens. Furthermore, access to Tinta Cocha is controlled by a Colombian patron in Villa Tinta Cocha. The only boats that enter are large (10 to 20 meters), and they are stopped on the way out of the lake, so that they can arrange to pay the patron for a portion of the fruit they harvest. Almost all of these locals had no previous experience harvesting the fruits. Nonetheless, the only way for them to quickly harvest the fruits from large boats is to grab the trees and shake them violently

("el sacude"). The stands of camu camu are dense in Tinta Cocha, and the situation gets chaotic, as maneuvering the boats is very difficult. As they fill with fruit, the people teeter on the edge of boats, leaping on and off the largest trees. This of course does great damage to the older trees. Much fruit is also lost in process. The new industry targeted this lake once it was discovered that its camu camu forests were not only very large, but older, and more productive.

El Estrecho was home to two processing plants, which functioned just two full harvest seasons, and are facing an uncertain future. The town was also visited at least twice by processing barges during these same years (1999-2000). One of the processing plants quit after just one harvest. Tinta Cocha is the main source of fruit there, but Cedro Cocha is also important. The camu camu there suffered less damage than in Tinta Cocha because it is less abundant, and more dispersed, making it hard to harvest from large boats. Here on the Peruvian side of the Putumayo River, Peruvians could freely enter the lake, and those with canoes took advantage of the open access. I was also told that the Peruvians had refused to cooperate with the Tinta Cocha boat operators in this lake. Still, haste and inexperience caused the people to do considerable damage to camu camu forests from just two harvests. As with the furious harvests in Tinta Cocha, the people know that the opportunity to sell camu camu does not come often to this isolated area of the Putumayo. Residents told me that given the chance, they will harvest the fruit as if there is no tomorrow, with little if any concern over damage to the trees.

In Supay-Sahua Cocha, the people harvested the fruit from canoes. These large twin lakes were well-known to researchers, and many at first thought them to be the largest camu camu forests in Peru. These lakes subsequently became the main source for the start of the camu camu export industry. Researchers, curious business people, then buyers and finally processing barges came to the twin lakes. They came from all over Peru. Processors from both Pucallpa and Iquitos exploited the lake. Operations were in full swing by 1995. This resulted not only in a rush to harvest the fruit, but in fierce competition between five local communities for this non-timber forest resource (Table 3-1). People worked all night with flashlights harvesting the fruits, and conflicts over perceived territories were common. Everyone complained about the maltreatment of the trees, but nothing could be done to control it. The buyers claimed to have prohibited tree climbing, and refused to buy the fruit from abusive harvesters, but the people said this was false, and they may have in fact encouraged the practice. Three to four buyers at once might be in the lakes, anxious to obtain a quantity of the perishable fruit as quickly as possible. As in the Tahuayo, the people had harvested the fruit for more than 10 years beforehand, sending it in much smaller quantities to Iquitos. Despite this experience, and use of canoes, damage here was the most extensive and heavy of any camu camu forest except that of Tinta Cocha. The main harvests here usually took place before Christmas, when there was great need for cash. Severe poverty in the Jenaro Herrera area probably worsened the situation.

The Nanay River camu camu in the study was located very near Iquitos, and exists in narrow stands along both sides of the river, and runs into Morona Cocha. Although it is called a lake, except in the driest months Morona Cocha is a small, alternate river channel that branches off the Nanay, next to the city of Iquitos. The camu camu here was long exploited for firewood, and these forests were said to nearly disappear before the fruit had a market. However, when the market for the fruit improved in 1995, the people mostly stopped this cutting for firewood. The census data appears to support this history, as nearly one-half of the trees were young in age, and only a small portion were mature (Table 6-2). Despite its ideal location, industry was not interested in this source of camu camu. It is one of the smaller sources, but the real problem is that there is no control over access to the fruit. People from Iquitos harvest the fruit at will, and often very early. Much of the fruit was in fact brought to processors in Iquitos, but usually in very small amounts. Most is rejected because it is green. Camu camu in this area tends to ripen early (usually by early December), making it some of the first to reach the local fruit markets. This early fruit will fetch a higher price than in January, causing immediate local competition for the resource. As with the Jenaro Herrera area, the holiday season also provokes this. This situation has made it impossible for large buyers to organize harvests in this location that can support industry.

The camu camu forests of the Tahuayo River had been exploited for the fruit for more than three decades, beginning in the early 1970s. Unlike Supay-Sahua Cocha, the new industry viewed these forests as secondary in importance, as they were said to produce around 40 tons of fruit in a typical harvest season[4]. Still, large buyers appeared with boats during two recent harvests, and processors in Iquitos made special efforts to monitor fruit development and exploit the resource on an annual basis. Thus the harvests were for the most part intense, but damage to the trees was usually light, with medium and heavy damage much less frequent than Supay-Sahua Cocha.

Two factors contributed make the impact from Tahuayo harvests different from those in Supay-Sahua Cocha: 1: Processing barges never came, and on-site cash payments were rare, and 2. Conflict between communities was minimal, resulting in better treatment of the trees.

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[4] Entrepreneurs usually considered camu camu forests that produced at least 100 tons of the fruit as a wise investment to exploit.

Two communities, Chino and Buena Vista (Chapter 3), harvested nearly all the camu camu in the upper Tahuayo[5]. Their residents have been involved with NGOs in a number of conservation projects that emphasize community management of natural resources (Bodmer et al. 1997). The village of Chino has a notable history of struggling to protect their aquatic resources (Penn and Alvarez 1990). On their own initiative and with their own resources, Chino established regulations for harvesting the camu camu. I was invited to two of these meetings where rules about harvests were agreed upon. The rules were made to limit the harvesting of unripe fruits, and prevent damage to the trees. The philosophy of these rules was guided by an ethic of fairness, so that every family would have a chance to benefit from the harvests. Sly entrepreneurs who arrived in Chino hoping to secure a lucrative deal for camu camu found that favoritism for a few, or domination of the resource was simply not permitted.

As in Supay-Sahua Cocha, dates were set for the first harvests, only in this case, the rule was followed in most years. Efforts to tax the harvests in Chino and limit the harvests by the neighboring village of Buena Vista were largely unsuccessful. There was some abuse of the trees, and conflicts with Buena Vista were common, but no where near the extent as reported in Supay-Sahua Cocha.[6] I observed three consecutive harvests in Tahuayo during this study (December-January 2001, 2002, and 2003) that were for the most part conducted in a skilled and conscientious manner. Evidence of damage was observed, but this damage was minimal, even after years of harvest. Findings from the forest surveys support these observations. For example, Tahuayo River camu camu had the highest incidence of light damage, which is the breaking of only the smallest branches. This frequent light damage (53%) is a sign of consistent harvest pressure, but at the same time, it is also a sign of efforts to limit damage. Given the recent history of this location, such findings are understandable.

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[5] The communities of Esperanza and Charo Cocha also harvested limited amounts of the fruit from very small stands of camu camu located downriver from the main source.

[6] As with people in the Jenaro Herrera area, the village of Buena Vista often harvested the fruit at night using flashlights, picking many green fruits.

Harvest Damage and Lessons Learned

The findings presented here exemplify the importance of comparing several factors when attempting to explain the statistical evidence of damage done to camu camu during harvests. We see that harvest methods, location characteristics, and degrees of access to the camu camu can influence the extent of physical damage to the trees, even when fruit buyers show up on site. However, the local presence of processing operations can destroy the good intentions of communities to manage their harvests in a way that limits damage and waste. Where several communities are competing for the same camu camu, it appears even more difficult to limit harvest damage through consensus. Local histories, customs, and economic need also influence the nature of these harvests. Above all, we see that statistically, the level of damage is dependent on tree age, but caused by human abuse.

Non-timber forest products tend to be severely depleted near urban centers (Neumann and Hirsch 2000), The Peruvian Amazon is no exception, and commercially exploitable quantities of many wild fruit-bearing trees can now only be found in more remote areas (Padoch 1988b, Vásquez and Gentry 1989). Findings from this study indicate that stands of camu camu located relatively close to urban centers such as the

Tahuayo have so far escaped major damage and that adjacent to the city of Iquitos, the Morona Cocha camu camu is no longer cut for firewood and appear to be regenerating. In fact, the findings here suggest that it is the camu camu stands located *furthest* from urban centers (the Putumayo) that are suffering the most destruction from the new industry, because processing operations have gone out and set up near these very large stands of the fruit. By comparing findings from several harvest areas across the region, this pattern emerges. The regional nature of this study allows us to compare and contrast different scenarios across the region, and detect patterns that might otherwise go unnoticed in a local study.

Environmental Implications of Camu Camu Harvests

What can we say about the environmental impact of the physical damage associated with these recent camu camu harvests? Evidence about the resiliency of *M. dubia* to harvest pressure and its ability to regenerate is limited. In a study from Sahua Cocha, Peters and Hammond (1990) found that fecundity in camu camu was significantly related to plant size. If so, and damage is also related to plant size, then these harvests tend to damage the most productive trees, and reduce fruit production. The consistent, repeated breaking of small branches will probably also reduce fruit production. Both these events would reduce seed dispersal, but this dispersal is already quite limited by humans collecting the fruits. Under such conditions, our short-term understanding of the environmental effects of these new harvests is indeed limited.

The patchy distribution of *M. dubia* in Amazonia is poorly understood (IIAP 2001), as well as the patchy local distribution of this species. The tree seems to prefer water that is “black” in color, but chemically, these waters may closely resemble “white water". The black water Tahuayo River, for example, lies within the Amazon floodplain and its waters have nearly the same chemistry and nutrient levels as the Amazon River (Coomes 1992). Some studies from Amazonia that examine the fruit and seed-eating diets of fish from the flooded forests and in particular the "tambaquí" (*Colssoma macropomum*) do not mention *M. dubia* as a dietary component of these fish (Goulding 1986, Araujo-Lima and Goulding 1997). However, it is well-known in Peru is that many fish consume the fruits, and that the fruit is important to the "gamitana" (Peters and Hammond 1990, Villachica 1996, Paitán 1997, Pinedo-Vasquez and Pinedo-Panduro 2002). Where camu camu has disappeared, so have the gamitana fish (Penn et al. 1993, Penn 1994). In this study the people also confirmed that the presence of camu camu attracted the fish, and was an important component in their diet.

Table 6-3 gives a brief, incomplete list at some of the fish that the people said most often consumed *M. dubia,* as well as fruit from the tree forms of camu camu, often called "shahuinto" (Chapter 1). This raises an important question. If large amounts of the fruit are taken by humans, how will this affect these fish species? There is certainly reason for concern, but too little is known about camu camu and these fish to draw conclusions. Goulding et al. (1996) and Lima-Araujo and Goulding (1997) rightfully express concern over the removal of floodplain forests in Amazonia, and the consequences for aquatic fauna. This study indicates that the commercialization of camu camu has led to some local protection of these forests. At the same time, the camu camu forests are protected for intensive human exploitation, almost a reversal of fortune for fish feeding on the fruits. Perhaps the most worrisome aspect of this situation is that the institutions involved with the Plan Nacional de Camu Camu (PNCC) have expressed almost no concern over this. The PNCC is not viewed as way for cultivation to replace the extraction of camu camu in the wild, but to *supplement* it.

Based on an examination of size classes of the trees, Peters and Hammond (1990) concluded that the camu camu in Sahua Cocha maintains a continual input of newly established seedlings. While acknowledging the removal of large quantities of fruit and seeds from the forest for markets, the authors felt that this had no effect on the regeneration of camu camu populations in the lake (ibid). This conclusion is questionable for two reasons: 1. The study involved only ten sample plots in this large lake, and 2. The camu camu forest there have been decreasing in size for the last several years, perhaps even before the industry arrived. Researchers at IIAP estimate them to be just one-quarter of the size they were in 1990 (Pinedo 2002). The local people often explained this to me, and asked for my opinion on the cause. It is tempting to point to the recent harvests, but this was not the first time I had heard of this problem, and before the new boom in camu camu harvests. In fairness to the authors, they note the difficulty involved with studying camu camu forests, especially due to unpredictable water levels (Peters and Hammond 1990). Their study is valuable, and reminds us of the lack of scientific knowledge about these forests.

Rapid Death of Camu Camu Stands

As explained in Chapter 4, the larger tree forms of *Myrciaria* will frequently regenerate as solitary specimens in open areas similar to other floodplain trees, but in *M. dubia,* with its abundant fruits, this is rare. This is not the only characteristic of camu camu distribution that is hard to explain. Large patches of productive trees will suddenly die, for no apparent reason. Researchers have attributed this to high floods or strong currents, and heavy sedimentation. The well-known and rapid disappearance of camu camu from Charo Cocha in the 1980s, in the upper Tahuayo, was attributed to such conditions. However, during my time in Peru, I observed camu camu thriving after years of exceptionally heavy and prolonged flooding, or covered in sediment, and exposed to strong currents. The local people confirmed this. The only fact we could agree upon was that sometimes camu camu dies in these conditions, or it might thrive. The people blamed a lack of gamitana fish, fishing with dynamite, and petroleum spills as additional causes for the disappearance of camu camu.

Vegetative Competition with Camu Camu

Competing Species

Although camu camu is found in floodplain forests where it forms dense aggregations (Peters et al. 1989b, Peters and Hammond 1990), it finds itself competing with several other species in the open sunlight. Large trees will occasionally be found scattered within the dense stands of camu camu (e.g., *Parkia* spp.), but it is the woody species similar in size and structure to camu camu that appear to compete for the same space. Like camu camu, these are water-loving species. In three of the study areas, spread across the region, these small trees appear to be colonizing the camu camu forest, or are actively expanding as they engulf the trees. In Supay-Sahua, dense stands of *Myrciaria inundata* ("fanacho", "fanache") now engulf most of the camu camu. This is the same species that quickly took over in Charo Cocha (Tahuayo River) when the camu camu began to die there. In the Nanay River near Iquitos, *Psidium* spp. ("sacha guayaba") is more abundant than camu camu. In the Putumayo, Cedro Cocha camu camu is being squeezed by *Erisma calcaratum* ("cacahuillo") and hemiepiphitic shrubs commonly called "renaquillo" (*Clusia* sp.) also hang from the camu camu.

In all three locations, the locals told me that the camu camu was disappearing. They explained that once these plants became abundant, they keep spreading, and the process wont stop. This was a matter of extreme concern to the local communities, especially in Sahua Cocha, where the process is so obvious. In terms of environmental impact, such changes are less clear. Most of these species produce fruits which are eaten by fish, like camu camu. They may even produce more fruit for fish than camu camu. Fanacho is very productive, and has a pink, very acidic fruit. I heard many reports that sly camu camu processors were mixing fanacho fruit in with the camu camu pulp to increase profits.

Silvicultural Treatments

One option to increase production of non-forest timber products is to manage the forests where they grow. This has probably been occurring for centuries, especially with palms (Smith 1999). Intensifying this management through enrichment and the thinning of forests is felt to be a good way to raise in-situ production of non-timber forest products while maintaining forest cover (Anderson 1990a, Neumann and Hirsch 2000).
The camu camu industry was also concerned about the effects on camu camu from competing vegetation. At least three entrepreneurs recruited teams of people in the Tahuayo and Jenaro-Herrera areas of the study to clear out the surrounding vegetation from camu camu during periods of low water. The people were paid or given food, machetes, and axes to do this. Results were mixed from these efforts. In Supay-Sahua Cocha, the camu camu was found to be supported by the surrounding vegetation, and

would often fall over in the mud if the fanacho was removed. In the end, these teams of men, usually 30 in number, were only able to clear a small portion (< 10%) of the camu camu. The people in Jenaro Herrera said it did no good, perhaps even damage, while the Tahuayo people said there was no change in the camu camu after the treatments. Meanwhile, the contractors also paid the people in Tahuayo to pull out unknown thousands of small wildings from the camu camu stands, which they carefully wrapped and took away. At least one NGO also did the same.

Anthropogenic Camu Camu Stands

It is incorrect to say that Amazon forests are "virgin" because upon examination, most of them reveal signs of human disturbance, and contribution to their existence. These anthropogenic forests are common in Amazonia, especially the palm forests, because people have used these forests for millennia (Goulding et al.1996, Smith 1999). We have seen that with the case of camu camu, knowledge of its early use is lacking, and even of contemporary traditional use. With the marketing of the fruit, we can begin to try to understand human impacts on these riverine forests during the last thirty years. This study has already questioned the most recent environmental impacts from the new industry. The focus is on potentially negative consequences. But what about impacts that might be viewed as positive? In this case, we mean human actions that may maintain or increase populations of this fruit-laden tree. For example, what about creation of human-induced stands of the trees?

In the upper Tahuayo River, I had observed one stand of camu camu that was noticeably larger in size and in the uniformity of the trees compared to stands nearby along the riverside. Local elders explained its existence. This dense and productive stand of trees had originated because boats had docked there in the past. During the first marketing of camu camu, in the 1970s it was hard to sell much of the fruit in Iquitos. The boat owners returned the unsold fruit to the people, who dumped it there in large quantities. As a result, a new and impressive riverside stand of camu camu was created by humans. This effort was not intentional, but incidental. During this dissertation research, I learned of a number of efforts to establish camu camu in lakes or on riversides by dumping large quantities of seeds that were obtained from processing plants. Indeed, we may soon see many new stands of camu camu that were established through deliberate efforts due to the impact of the export industry.

Conclusion

Differences in the extent and level of damage existed between the camu camu forests studied across the region. Levels of damage were dependent on the age of the trees, and older trees suffered the most damage. Previous studies suggest that this pattern may have a negative effect on fruit production. More research is needed to improve our ways of understanding and measuring this damage. The recent harvest may have a negative impact on fish populations, and more research is needed to understand the population biology and habitat use of this aquatic fauna.

The presence of processing plants and on site buyers appeared to be one cause of physical damage to these forests. Local experience and ability to harvest the fruits was another factor. Damage to camu camu forests was greater in areas far from Iquitos, rather than near the city. These findings question previous assumptions about market access and extractive activities in the Peruvian Amazon.

Community efforts to limit damage to wild camu camu are important, and may indeed be working in some areas. Populations of camu camu were quite unstable in some areas and competing vegetation appears to be taking over camu camu habitat where some of the most important commercial sources of the fruit exist. Local residents were quite concerned about these changes, and are looking for ways to prevent the loss of wild stands. Humans are altering the environment where camu camu lives, with unknown consequences. Persistent harvest pressure on camu camu is not predatory in that it kills the trees, but appears to cause a general degradation of their condition and ability to regenerate.

The results presented in this dissertation are preliminary. Long-term studies will have to be carried out if we are to begin to understand the resilience of the camu camu stands to commercial harvests. Thus, the sustainability of these harvests and the industry itself remains in question. More research is needed to improve our understanding of the environmental impacts of camu camu harvests.

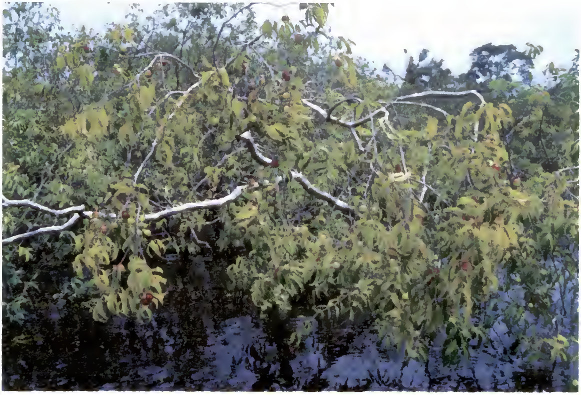

Figure 6-1. Heavily damaged camu camu.

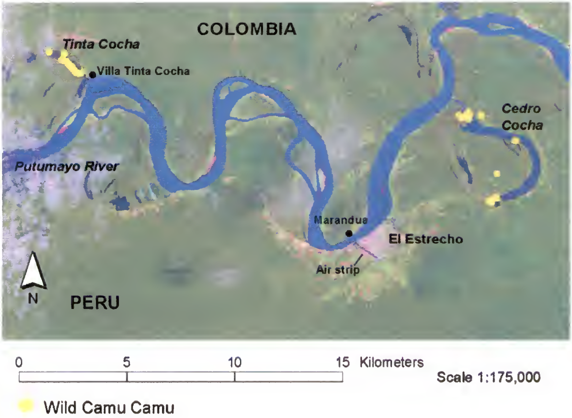

Figure 6-2. Camu camu extraction areas near the town of El Estrecho, Peru.

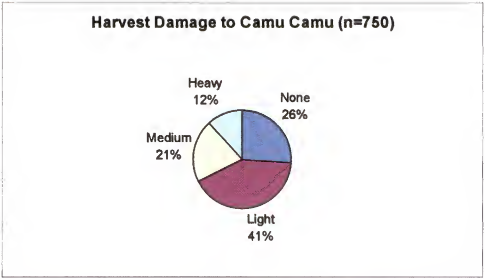

Figure 6-3. Overall frequency of harvest damage in sample plots.

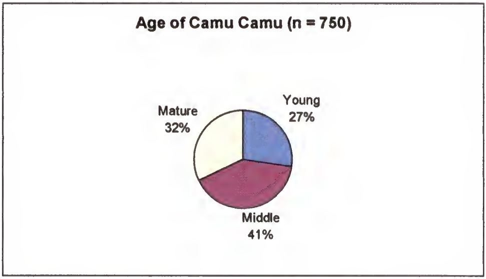

Figure 6-4. Overall frequency of age classes in camu camu forests.

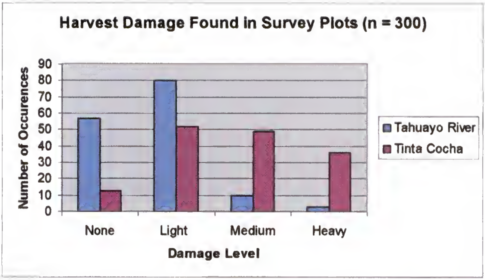

Figure 6-5. Harvest damage to camu camu compared between the Tahuayo River and Tinta Cocha

Damage level	None	Light	Medium	Heavy
Cedro Cocha	26	42	23.3	8.7
Tinta Cocha	8.7	34.7	32.7	24
Supay-Sahua Cocha	17.3	40	25.3	17.3
Tahuayo River	38	53.3	6.7	2
Nanay River	40	37.3	16	6.7

Table 6-1. Frequency of damage in sample plots by location.

Age of trees	Young	Middle	Mature
Cedro Cocha	42.7	34.7	22.7
Tinta Cocha	16.7	46	37.3
Supay-Sahua Cocha	10.7	44.7	44.7
Tahuayo River	18.7	36.7	44.7
Nanay River	47.3	42	10.7

Table 6-2. Frequency of camu camu age classes by location.

Vernacular name	Scientific name	Preferences	Form of consumption
Gamitana	*Colossoma macropomum*	*M. dubia* preferred	Eats whole fruits
Paco	*Colossoma bidens*	*M. dubia* preferred	Eats whole fruits
Cahuara	*Pimelodus* spp.	Tree forms most often, and eats *M. dubia*	Eats whole fruits
Sabalo	*Brycon* spp.	Both *M. dubia* and tree forms	Eats pulp and seeds
Lisa	*Leporinus* spp.	Both *M. dubia* and tree forms	Eats pulp, spits out seeds

Table 6-3. Incomplete list of some of the more common fish that feed on camu camu. Species names: Villarejo 1979, Goulding 1986.

CHAPTER 7

ECONOMIC IMPLICATIONS OF THE NEW CAMU CAMU INDUSTRY

Introduction

In the lowland Peruvian Amazon, a poorly developed transportation and communication network, lack of storage and processing facilities, and changing marketing chains over vast distances make the marketing of non-timber forest products (NTFPs) a risky business for the rural poor, as well as for contractors and middlemen. In this environment, marketing perishable fruits involves even greater risks (Padoch 1992). To Homma (1996), the viability of extractive economies is largely dependent on their ability to provide social improvements for those who participate in them, with economics being their “Achilles heel” (p. 3). Despite the large body of knowledge on peasantry and their integration into markets, we know relatively little about the patterns of income distribution between communities and within regions from NTFPs (Neumann and Hirsch 2000).

The impact of international trade in forest products on the people and communities in the lowland Peruvian Amazon has a long but also recent history of its own (Villarejo 1979, Barclay et al. 1991, Coomes 1995). After the rubber boom, the region has experienced more recent, smaller, economic "booms" in non-timber forest products, and the rural people are alert and anxious for a new "boom" from another forest product that will lift their local economy. However, little permanent economic development has resulted from these brief periods of affluence. Such booms can also cause major disruptions in the lives of rural communities (Padoch and de Jong 1990). To Homma (1992, 1996), the unstable nature of forest product extraction is due to a number of interdependent causes, which make extraction a temporary, but unviable economic activity in Amazonia. However important these extractive products are to income and subsistence, they should be viewed as supplement to incomes on the Amazon floodplain rather than primary sources of income (Smith 1999).

For internationally traded products from small farmer agroforestry systems, production and transportation costs will continue to dominate decisions regarding where, how much, and how to produce (Vosti et al. 1998). It was shown how this was not the case with the PNCC (Chapters 3-4). Nevertheless, Padoch and de Jong (1989) are critical of the economic gain obtainable through swidden-fallow agroforestry systems in the region because only a small percentage of the retail value of these products is earned by the farmer. Many of these products are in fact NTFPs that come from managed fallows. The same is true for extracted NTFPs, where middlemen and contractors make most of the money from these products, rather than the ribereños (Padoch 1992). However, camu camu is seen as exceptional, somewhat of an anomaly among non-timber forest resources (NTFRs) because it is such a productive species, and brings such high returns per unit of harvest area. For these reasons even researchers concerned about the future of Amazonian forests endorsed camu camu as an exceptionally valuable NTFR, and economically viable extractive activity (Peters et al. 1989, Peters and Hammond 1990, Vásquez and Gentry 1989, Villachica 1996, Paitán 1997). For the same reasons, even critics of NTFP commercialization also point to camu camu as a special case, and one of great promise for rural inhabitants (Neumann and Hirsch 2000). Meanwhile, experts caution that small new NTFP industries may be ill-equipped to handle the stringent demands of international markets (Butler 1992).

As for the new camu camu industry, what has been the early pattern of development, and who reaps the benefits? How have rural families and their and communities benefited from camu camu harvests? How do logistics of the Peruvian Amazon effect the industry, or economic conditions in Peru? This chapter is guided by these questions as it seeks to understand the nature of the early, but import economic implications of the camu camu industry. First I examine how the different study areas have benefited economically from the export industry. Efforts to exploit the fruit to establish the processing industry are discussed, with an emphasis on the relationship between location and development. I then review some of the obstacles to development of industry in the city of Iquitos, with comparisons to the case of Pucallpa, including recent national trends in Peru. Household earnings in rural communities from camu camu are presented in order to help explain the local and regional variations in earnings, recent shifts in benefits, and the challenges facing rural communities that are marketing the fruit. The recurrent theme of boom and bust periods in Amazonia emerges throughout the chapter.

Methods

The data presented in this chapter was obtained through participatory observations during harvests, and by traveling in boats loaded with camu camu for market. I witnessed the buying and selling of camu camu at ports, and visited processing plants in Iquitos (Camu Camu Export S.A., Planta Modelo-UNAP) and El Estrecho (Peru Amazon Export S.A.). I also visited the Backus and Johnston facility in Pucallpa, but was not allowed to view the processing areas. Throughout this process, I interviewed the many people involved. These included rural residents and industry representatives, processors, plant managers, investors, marketing specialists, camu camu buyers, transporters and intermediaries. Harvest figures and earnings were calculated from data obtained by these methods and government documents.

Estimating Rural Earnings from the Camu Camu Industry

Estimates for earnings from the camu camu industry in the four study areas (Table 7-1) were based on records kept by the government and research institutes, verbal verifications by industry representatives, and my own data obtained through interviews and observing the actual transactions involved with camu camu commercialization. These figures are estimates based on the reported or observed quantity of camu camu harvested, and the price per kilo that was paid for the fruit. These are conservative estimates, as losses of fruit by processors were frequent and impossible to estimate, but not included in export figures. The exchange rate for converting the costs to US dollars was 3.5 Nuevos Soles: 1USD.

To estimate wages earned from rural work with the processors (e.g., on barges, in processing plants, clearing out camu camu stands) I multiplied the standard daily wage by the number of people working. Again, these are estimates, and difficult to verify. Estimates of employment were based largely on interviews with plant managers. The number of households participating in the harvests was estimated based on findings from local interviews. Not all households in these communities participated in harvests and even less in local employment.

Economic Benefits of Camu Camu to Rural Areas

Income for Rural Communities

Estimates of tonnages and earnings from harvests from three of the four extraction areas of the study are presented in Table 7-1. Harvests from the Nanay River near Iquitos were not included. The harvests there were small and disorganized compared to the other areas, and rarely targeted by industry buyers. A total of 1,600 MT of fruit was estimated to have been harvested from these four areas since the beginning of the export industry. Total net earnings for communities were estimated to be $307,571.90, of which $246,542.30 was from sales of fruit. More than four-fifths of these earnings (80.2%) were from sales of the fruit, and about one fifth (19.8%) were from employment generated by the industry.

Government figures (Picón and Acosta 2000) are based on pulp production as reported by industry, but much more was harvested from the wild. The local people reported where their camu camu was going, and plant mangers verified purchases and prices paid for the fruit. Significant portions of these wild harvests from Supay-Sahua Cocha in the Jenaro Herrera area and the upper Tahuayo River were not processed, instead being sold as fresh fruits in Iquitos markets. Thus, findings from this study presented in Table 7-1 include harvests that I learned of that were not processed or not reported to authorities by industry.

The figures in Table 7-1 represent net earnings from the fruit. This is the price the camu camu pickers, or rural harvesters, received for the fruit. The highest net earnings per kilo were in the Putumayo River (.229), while the lowest earnings were usually found with camu camu that was sold to be marketed as fruit in Iquitos, rather than to processors.

The most recent harvests in the Jenaro Herrera area and the Tahuayo River are examples of this. Considerable variation existed in the net earnings from the fruit, depending on the buyer, where the fruit was purchased, supply and demand for the fruit, and transportation costs. Harvest levels also varied, as floodwaters destroyed much fruit in some years, and buyers were only occasionally present in El Estrecho. While these are rough estimates, they give a clear idea as to the amount of money earned by rural residents in the study areas from the fruit.

Findings presented here give a lower market value to the fruit than estimated by Peters and Hammond (1990). The authors estimate the market value of one hectare of wild camu camu to be from $5700 to $7620. This was based on estimated yields of 9.5 to 12.7 t/ha/year. Peters (1992) later adjusts this figure to $6,660, which is simply an average of the previous figures for yield and value. To obtain the economic value of the fruit, calculations were based on an estimate of retail prices in Iquitos markets for camu camu. There, a 500 g bag of the fruit sold for .30 (USD), which converts to $600 MT. These are gross earnings. Still, even when camu camu sold at its highest price, .29 per kilo, the gross value is $290 MT, less than half that reported by the previous study. This shows the need for caution when attempting to calculate the value of NTFPs, and the danger in using retail market prices for small quantities of fruit as a gauge of their potential economic value as a natural resource.

Marketing Camu Camu from Rural Areas

When camu camu purchasers came directly to the harvest sites, it was common to pay the locals .50 Nuevo Soles per kilo or .145 (USD). Most income from NTFPs sent by ribereños to market in the region ends up in the hands of middlemen, rather than the extractors (Padoch 1992). This on-site pay was exactly what the locals wanted, as they did not have to expend effort shipping the fruit to market and worry about shipping costs, damage or spoilage to the fruit, lost containers, or the uncertainties involved with its actual sale. Above all, they knew what they would receive even as they picked the fruits, and have cash in their pockets that very day. El Estrecho residents received the highest prices from exclusively on-site purchases. While camu camu buyers stressed that they wanted to compensate the locals well for their work, it may be that the socioeconomic situation of this area (violence and the drug trade) influenced the price. The price paid at the processor door was often .29USD, but Colombians controlled access to Tinta Cocha and charged a tax on these harvests, reducing net income for the harvesters.

Sending fruit to market meant the camu camu pickers must rely on intermediaries to take the fruit to the processing plant, as few ribereños knew how to do this, or wanted to go to Iquitos with their cargo and try to do so (see Padoch 1992). Local residents who took the fruit to the processors were usually store owners or patrons and kept a portion of the earnings for themselves, and the harvesters were well aware of this.

If the ribereños had to ship the fruit to market, the shipping rate ("flete") was one to two soles (.29-.58 USD) for approximately ten kilos of the fruit for the fluvial transport services that served these communities. Like so many other products, residents would send their camu camu market and let the boat owners sell it, or allow community members (usually local store owners). However, it was not as if these intermediaries simply subtracted the shipping costs from the price they received from the buyers. They usually pocketed at least 25% of this, if not more. For example, Camu Camu Export in Iquitos was paying a minimum of .80 nuevos soles per kilo (.23 USD). However, the most that was ever returned to the harvesters was .50 nuevos soles (.145 USD), with the local patron or storekeepers making about half of the difference once their transport costs were accounted for. Moreover, with camu camu prices falling in the Iquitos market since 2001, boat owners were simply returning to communities and paying them whatever they could, or wanted to pay, which had fallen to between four and six cents a kilo. This marketing situation and price instability is well-known to rural inhabitants, and applies to most NTFPs. My estimates of net earnings are what the harvesters actually received for the fruit, although boat owners and intermediaries probably made at least 25% on top of this. The purpose is to understand what the harvesters and rural communities were earning through this new industry.

From the data in Table 7-1, we can see that the net earnings per ton varied from \$43 to \$229. Spread over 10 year period, during periods of high and low demand, the net earnings for the camu camu pickers averaged \$154.04 MT. These figures may appear sobering next to those of Peters and Hammond (1990), which are four times greater. However, when compared to other extractive activities, especially fruits, camu camu harvests suddenly appear quite attractive, and are anxiously awaited by the ribereños. What explains the attraction of these harvests?

To begin with, camu camu harvesting requires no investment (Peters and Hammond 1990). Extractive activities such as fishing, hunting require investment in equipment (fish nets, shotgun shells, gun, food) plus considerable time and physical exertion. There is a risk of returning with nothing, or very little. Fish nets are costly, and routinely damaged or stolen. Even harvesting wild fruits in great demand such as aguaje (*Mauritia flexuosa*) involves considerable time, effort and risks. Aguaje was considered to be the most economically valuable fruit in the Iquitos markets. Extractors may spend days in canoes searching for these palm fruits, and travel great distances in the forest with the heavy sacks of fruit on their backs (Padoch 1988b, Vásquez and Gentry 1989). Like camu camu, aguaje ripens unevenly, but it is almost impossible to climb the palms in the wild. Because the trees must be felled for harvesting, much of the fruit is unripe or unfit to send to market. Unless of exceptional quality, wild aguaje typically is sold for just three to four dollars for a 50 kilo sack in Iquitos, and shipping costs are about .60 (USD) per sack. Despite great effort to locate, extract and ship the fruit to market, aguaje typically earns just about $60 to $80 MT for the extractors. This does not include the time or money spent on food during the hunt for the fruit.

Compare the situation of aguaje to that of camu camu extraction. With camu camu, the fruits are located close to villages, and the people go out in canoes and simply pick them by hand. No investment is required except a canoe, which most people have. The bulk of the harvests occur during a period (December – February) when there is little else to do in terms of agricultural work, and children are not in school. The work is not strenuous, but quite light compared to most other work. The people simply decide if they want to pick the fruit on a given day. The more they pick, the more they earn. If only a few fruits are ready for picking on the trees, they can stop and return to other tasks that same day. Many men remark that camu camu is “women’s work”, and “kids work” because it is so easy, but the men themselves do not pass up this chance to earn easy money. In El Estrecho, where canoes are scarce and large boats had to be rented, the work was still risk free, because the processing plants informed the people ahead of time if they would need camu camu, and harvest outings proceeded accordingly.

Household Earnings from Camu Camu

If we break down the data presented in Table 7-1, we can estimate household earnings from these harvests. The highest household earnings were in the town of El Estrecho, where approximately 200 households earned a mean annual income of $1045.22 from harvests since 1998. The higher earnings are due to a higher on site price paid for the fruit and the presence of two processing plants in the town. In Tahuayo, the ribereños reported that around 40 households in two communities harvested the fruit. If the earnings are broken down equally, this would give a net income per household of $693.93, or about $87 on an annual basis. In a recent report by Pinedo (2002), the actual figures for earnings in Tahuayo are not given, but they are considered to represent 12.4% of the annual household incomes there. In Jenaro Herrera, the mean household income from camu camu was $359.90 per family, or about $36 on an annual basis spread across approximately 200 households in five communities. As with the Tahuayo, there was much variation in earnings per kilo, and the size of harvests since 1994.

Economic Impacts of Camu Camu in Rural Communities

Income from the camu camu industry in the Tahuayo and Jenaro-Herrera area varied considerably from season to season. Camu camu harvests in both areas were very small in 1994, 2002, and 2003. Thus it is useful to consider local earnings over a period of seven years, which raises mean annual earnings considerably. When we consider that a typical ribereño household has an annual income of less than $350 (Coomes 1995, Coomes and Burt 1997), this makes earnings from camu camu quite important and comparable to the estimates by Pinedo (2002). These local earnings are even more significant when we consider that most of this income was earned from once or twice weekly harvests over a period of two months. In other words, about a dozen easy working days are all that were needed to net these earnings, and many of these are half days.

In both the Tahuayo and Jenaro Herrera area, the harvests are crucial for household earnings because the harvest period (December-February) comes at a time when they produce very little income. Many families told me that camu camu was their only significant source of income in these months. My own observations concurred with these opinions. Storekeepers and river taxi operators also verified this. We must remember that this was an injection of several thousand dollars of cash into these seven impoverished communities when they usually had virtually no money and needed to make purchases for the Christmas holiday and school needs. In El Estrecho, there was even more income. It came beginning in late January, when camu camu starts to ripen in the Putumayo. For the ribereños and the small stores and bars in their communities, this simultaneous community jump in income was nothing short of a local economic boom, and from a resource that was not destroyed or exhausted in the process. The same source of this income was there each year, awaiting exploitation, and the ribereños were well aware of this.

These estimates should be considered as minimum earnings by these communities, as they probably harvested more fruit than records indicate. I was only able to observe harvests and shipments of fruit from harvest zones during 2001-03. Camu camu entrepreneurs told me that they frequently had problems with processing the fruit and had to dispose of large quantities of pulp. Believing that the ascorbic acid content of the fruit was higher when the fruits are green, they also processed many tons of green fruits to impress perspective buyers, only to have this pulp rejected. This gives us good reason to believe that these communities earned significantly more from camu camu than was shown in Table 7-1.

Some families displayed great skill at harvesting the fruit, and an adult-child team in canoe could harvest 60 to 100 kilos a day. I observed some large families picking 200 to 250 kilos of fruit a day, with net earnings for a single day as high as $28.57 to $35.71. Such earnings rival those obtained from fishing with large nets, hunting, charcoal-making, and agricultural harvests. However, all of these activities require investments of time, money and carry significant risks, while camu camu does not.

A significant portion of these earnings were from wages paid to the ribereños (Table 7-1). In Jenaro Herrera, this was through seven years of employment on the processing barges, usually 12 to 20 persons at a time. Groups of 20 to 30 men at a time were also paid during the summer months (July-September) to clear the camu camu stands of competing vegetation. The pay was usually 10 nuevos soles per day (2.85USD), and the men also received free axes and machetes as incentives to maintain the stands without pay. In the Tahuayo, this work was also done, but only on two occasions. As the main In El Estrecho, there was much seasonal employment generated in the local camu camu processing plants. The camu camu was processed into pulp, put into plastic buckets, and frozen for shipping (usually by air to Iquitos). Mostly women worked in the two different plants, up to 50 at a time, and were paid 20 nuevos soles (5.71USD) to work an eight hour shift.

Non-timber Forest Products and Local Earnings

It was shown that camu camu harvesting compared quite favorably to the extraction of aguaje palm fruits, another important regional economy. Padoch (1992) argues that economic benefits from NTFRs are inevitably minimal for ribereños because middlemen and intermediaries pocket most of the money from their sale. Padoch and de Jong (1989) show how less than 5% of the value of swidden-fallow agroforestry products is returned to farmers, including several common NTFPs harvested from managed fallows. How does the case of camu camu compare to this study?

Frozen camu camu pulp sells for \$3.50 a kilo[1]. Approximately two kilos of fruit yield one kilo of pulp. If we use the typical price received by harvesters (.145USD), this means that at least .29USD is given back to the ribereños for every kilo of frozen pulp[2]. This is 8.3% of the value, about twice as high as what Padoch and de Jong (1989) reported for common NTFPs. These are rough estimates, but camu camu harvesters appear to have received a higher percentage of the value of camu camu pulp than they usually do from marketing other NTFPs. When the ease and risk-free nature of these harvests is considered, camu camu extraction appears even more favorable economically for the ribereños than traditional NTFP extraction. As many middlemen are locals, and taxes levied on the fruit are local, yet more income returns to these communities than is shown here. Still, as Smith (1999) emphasizes, NTFRs should be looked upon as supplements to incomes on the Amazon floodplain, rather than sole sources of income. We do not know of the profits from camu camu that were made by the businesses involved, but firm representatives told me that the costly logistics of obtaining fruit, processing, storing and shipping the pulp were absorbing potential profits.

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[1] Hector Yamakawa, Peru Amazon Export S.A., personal communication. 2002

[2] A bit more income is given back for each kilo of pulp, as there are losses of in the process.

Quick Booms and Recent Declines in the Industry

In reality, most of the earnings from the new industry in these three areas occurred during brief periods when prices were highest. In Tahuayo the earnings were spread more evenly over the eight year period, but in Jenarro Herrera most income came from the years 1996-98. In El Estrecho, nearly all income came from 1999-2001, just three harvest seasons. No purchases of significance were made in 2002. There is a noticeable drop in earnings since 1999 in the Tahuayo and Jenaro Herrera areas. This is because the buyers discovered the much larger quantities in the Putumayo River, and due to problems with selling the frozen pulp.

What explains the more even earnings in the Tahuayo? When in need of smaller amounts of the fruit, the Tahuayo was an easily accessible and economical source of camu camu for many entrepreneurs, especially those experimenting with small production runs. Thus the Tahuayo area was able to benefit from its location near Iquitos, even with price drops in the fruit. This may also help explain the successful local efforts to manage these harvests, with easy access to this resource in this case providing an incentive for community management (Chapter 6).

Though not publicly acknowledged or published, processors in Japan discovered the pulp contained high levels of bacteria and were contaminated with other organisms present in the dirty water of Iquitos. This was common knowledge among experts. Vitamin C is a labile micronutrient (Levine et al. 1999). In order to prevent losses of Vitamin C, the firms did not pasteurize the pulp or use heat during processing. Quality control requirements could not be met, and purchases of fruit for export had almost disappeared since early 2001. This has caused great consternation in communities. It was also a disappointment to farmers who are cultivating the fruit. As Butler warns (1992), small, new industries may be ill-equipped to handle the stringent demands of modern markets for NTFPs. It appears as though the camu camu business finds it itself in this situation.

Prices paid to the ribereños sending the fruit the Iquitos markets are much lower than they received from industry buyers. During 2002-03 prices were just one-third of what they were in previous years (Table 7-1). Precisely because the work is so easy, the people still continue to harvest the fruits at almost the same level as during the boom. Now with less industry demand, this floods Iquitos markets with fruit, causing prices to again drop. The situation is worsened by the large amount of green (unripe) fruits that are sent to market in a desperate attempt to earn more. This probably earns the ribereños *less* income because frustrated buyers in Iquitos will point out this problem when they purchase the fruits, and lower their offer.

Most people in Tahuayo and the Jenaro Herrera area were earning just one or two dollars a day picking the fruit in the most recent years. However, the ease and risk-free nature of the work still makes it attractive to many people. Being paid to do weed gardens, for example, is considered a lucky job, but this is very strenuous work, and the pay is four to seven soles per day ($1.14-$2), about the same that people can earn picking camu camu during times of price drops. Again, there are very few sources of quick cash at this time of year for the ribereños. Iquitos can consume about three tons of the fruit daily[3], so the main market for the fruit still remains domestic, and in this city. Thus, the early boom in camu camu demand has seen a sudden decline, although the fruit still has value.

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[3] Carlos Santillan, Chief Manager, Camu Camu Export SA, personal communication. 2002.

Location, Camu Camu, and Development

Isolation and the Industrialization of Camu Camu Fruit

Development projects in the Amazon have long been affected by the sheer isolation of the region (Moran 1981). In Amazonia, location must be taken into account when a project is elaborated. This is why the production of high-value products from NTFRs are the best market option for isolated Amazonia if it is to develop these resources (Gilbert 1995). Well before the PNCC, Peters et al. (1989b) emphasized the great potential economic value of the oligarchic forests of camu camu in Peru. The authors stressed that a major limitation to the successful economic exploitation of these forests is their isolated location. They concluded that regional transportation and processing infrastructure must be improved so that the perishable fruits can be quickly transformed to value-added products. With camu camu, the operations of the new firms were inhibited by the costly logistics of obtaining, processing, and exporting the fruit. Even in Iquitos, they were also constrained by a lack of water and electricity services necessary to process and freeze the camu camu pulp to the required standards. After contamination of the pulp caused Japanese importers to demand improvements, the processed pulp was sent from Iquitos and reprocessed in Lima in an attempt to sterilize and properly freeze the pulp. This further absorbed any potential profits to be made from fruit pulp, and it is unclear if the effort was successful.

For internationally traded products from small farmer agroforestry systems, production and transportation costs will continue to dominate decisions regarding where, how much, and how to produce (Vosti et al. 1998). Fruit, more than any other export item, needs streamlined infrastructural bases and distribution networks to become internationally competitive (Caviedes and Muller 1994). The case of the acerola export in Brazil provides important insights when analyzing the challenges that the camu camu industry faces in Peru. The production of acerola fruit (*Malpighia emarginata*) in Brazil faced many problems because of the way it was initiated. The transformation process and the use of the fruit (mostly for vitamin C) are almost identical to that of camu camu. The fragile, vitamin C-rich acerola fruits had to be sent long distances to processing plants (Alvez et al. 1999). Transports costs were high, as was the portion of fruits that were damaged or spoiled, and then rejected by the processor. Furthermore, the processed pulp was often rejected by buyers due to poor taste and failure to meet sanitary requirements. To prevent the collapse of the industry, acerola fields were relocated close to the processing plants. The fruits must be harvested by hand, quickly processed, and the pulp is frozen in barrels for shipment to the United States. So far, camu camu cultivation has occurred mostly in the locations of extension agency territories (Chapter 3), a situation that has presented a number of potential problems for the new industry and for farmers.

The common assumption in Peru was that domestication of camu camu through the PNCC would solve problems of supply by supplementing wild harvests. But what about getting that supply of fruit to buyers or processors? A major complaint by processors about these wild harvests was the damage and spoilage that occurred to fruit, let alone the slow speed of boat transport to Iquitos. Rural residents who sent these harvests to market complained about the high freight costs for camu camu imposed by boat owners. There is evidence that domestication of camu camu seeks to solve this problem of spoilage and high transport costs, but not from Peru. Smith (1999) notes this about the Brazilian efforts to establish camu camu plantations near Sao Paulo in order to have a production center close to urban markets. Findings from my research in Brazil revealed that a similar effort is taking place outside of the city of Manaus, where some 70 hectares were planted in order to easily supply processors in that city. What might explain the lack of such a pattern in Peru?

Uneven Development in the Peruvian Amazon

Iquitos is famous for its geographic isolation, and has long been considered the most isolated city in the Amazon (Freilich 1999). The city is a commercial center for an enormous area of the Peruvian Amazon. Almost everything that is produced for market along the lower Ucayali and Marañon Rivers, the Amazon, the Napo, and their tributaries, finds its way into Iquitos (Padoch 1992). As the only major urban area in Peru's largest region of Loreto, Von Thünen's Isolated State model might at first appear appropriate for predicting land use trends in this land rich, but infrastructure poor region.

The physical geography of the Amazon (or practically anywhere for that matter) makes it easy to understand why planners and farmers could not organize agricultural production in series of concentric Von Thünen rings around Iquitos. However, numerous studies have emphasized the importance of access to market for farmers in the region, and the market-oriented nature of agroforestry systems near Iquitos. These studies illustrate how farmers organize their cropping strategies in relation to their access to the urban center (Hiraoka 1986, 1989, Padoch and de Jong 1987, Coomes 1995). Without refrigerated cargo holds, the intensity of extractive activities for NTFPs in the Peruvian Amazon also varies in relation to distance to market (Padoch 1988b, 1992, Vasquez and Gentry 1989, Bayley et al. 1992, Durand and McCaffrey 1999).

These examples suggest that Von Thünen's notions of centrality are still pertinent for small scale agroindustry in many parts of the Amazon. Most Amazonians are urbanites, and urban demands have promoted the development of rural areas outside of Amazon cities (Browder and Godfrey 1997). Peri-urban agroforestry in the Brazilian Amazon is an overlooked phenomena that is probably more common and important than previously recognized (Slinger 1999). However, Walker and Homma (1996) stress that recent development in Amazonia has not in any way followed a pattern of intensity along the lines of Von Thünen's model, and is in fact characterized by an unevenness of intensity, regardless of the location of urban centers. This is indeed a characteristic of the areas surrounding Iquitos, and not only in the case of the PNCC.

In the immediate vicinity of Iquitos, it is rare to see intensive vegetable farming on the floodplain to supply the needs of this urban area, which is common in Brazil (Smith 1999). Instead, most vegetables come by long distance from coastal and mountain regions of the country. During the 1980s, the government embarked on a large program to raise water buffalo and create pastures near the city of Iquitos. The program created many conflicts over lands that were already dedicated to crops. Critics of the program argued strongly that lands near Iquitos should be used for food crops, rather than large expanses of pasture (Casa Campesina 1985). Many floodplain communities located near Iquitos have a history of resisting programs that promote extensive agriculture supported by local industry, such as sugar cane and jute plantations. They have preferred to maintain local forests and manage old fallows, even hunting grounds, very close to the expanding urban center of Iquitos (Pinedo et al. 2002). We saw a similar form of resistance to camu camu planting with the PNCC (Chapters 3-4). Still, it seems odd that the PNCC was not planned to compensate for the lack of infrastructure and needs of processing plants. This chapter has shown that in the beginning, it has been the processors and markets that have gone to the source of the camu camu. Meanwhile, farmers soon to have crops of camu camu are hoping that processors will do the same for them.

This situation near Iquitos contrasts the reports of Goulding et al. (1996) that areas of the floodplain near urban centers in Brazil are most vulnerable to agricultural intensification. However, near Pucallpa, findings suggest that land use intensity on the floodplain does increase as one nears the city (Chapters 4 - 5). A lesson from Brown (1988) may shed light on what we can learn from these contrasting studies and the situation with respect to Iquitos and the PNCC; namely, that Third World change and development experience are recent processes, spanning barely half a century. Broader processes may not be discernable in the midst of events.

Challenges and Realities of Geographic Isolation

From a commercial standpoint, the relative location of Pucallpa is seen as superior to that of Iquitos. Freilich (1999) argues that Pucallpa is the only true commercial center in the Peruvian Amazon because it is connected by road to other major cities, while Iquitos lacks such connections. This situation allows Pucallpa to develop in complementary ways to these cities. While the author does not say so, the implication here is that Iquitos is far too dependent on secondary, over-extended, and expensive economic linkages that inherently retard its development. Browder and Godfrey (1997) emphasize how urban demands have promoted the development of rural areas outside of Amazon cities. This analysis is based on central-place theory, and argues that the rapid growth of these cities spurs development. Urban population growth fosters expanding, more diverse markets, but this process is fueled by the expansion of local industries (e.g., metal processing, saw mills, agroindustry, including cattle and feed processing) to supply other regions of Brazil, playing an important role in the national economy. This may be happening in Brazil and in Pucallpa, but not in Iquitos.

Peru is one of a group of countries in South American that have been especially unable to overcome the challenges posed by the isolation of their urban centers in the interior of the continent. This not only retards development, but also the *sustainable* local development of these urban centers (Bonifaz et al. 2002). A look at Iquitos provides examples of this. The city has grown rapidly in population during the last quarter of a century, with an annual increase of 2.7% in recent years (INEI-Loreto 2000). But this growth may have outpaced needed development. Despite the abundant petroleum exploited in the region, industrial production there is limited and now smaller than in the past (INEI-Loreto 2000). A major reason for this is that electrical current is poor and erratic. This makes it impossible to power modern driers for quality plywood and lumber, limiting the capacity of local sawmills, who don't have the capital to modernize their operations. Iquitos saw mills do not even mill finished wood for housing needs, as in Pucallpa, despite having twice the population of Pucallpa. Electrical appliances, especially refrigeration units, quickly deteriorate. Camu camu pulp cannot be frozen to the necessary temperature requirements and must be sent to Lima for refreezing. Most of this freezing done in Iquitos is done by separate power units, independent of the local power plant.

Poor water quality continues to plague the city. The only canning factory that currently meets national sanitary or export requirements in Iquitos is that of a small business that runs only sporadically, often idle for weeks. During this study, the Coca Cola plant ceased to operate due to water and quality concerns. For nearly a year, this brand of soft drink was rare in the city, and had to come by plane from Lima. Repeated calls by politicians for a modern fruit processing plant, that would spur growth in agriculture, have gone unanswered for decades.

The petroleum boom of the 1970s and 80s in Loreto that provided so many good jobs for Iquiteños has also contracted in recent years. After almost twenty years of increases, petroleum production began to fall in the late 1980s, and with it, employment (Valcárcel 1991). Privatization and a lack of new exploration led to a huge reduction in the number of petroleum workers in Iquitos, and reduced operations in the Iquitos refinery.

To grow economically, Third World nations must find and expand niches in industrial-technological marketplaces that are already mature (Brown 1988). Iquitos' isolation only makes this reality more difficult. It is no wonder that planners have turned to the unique qualities of NTFPs in the region such as camu camu to promote economic growth. But even with these products, competition exists and develops. The production of "uña de gato"(*Uncaria* sp.) and "sangre de grado"(*Croton lechleri*) products by cottage industry in Iquitos for sale elsewhere has benefited some people, but these businesses are small, and neighboring Pucallpa and Ecuador have become the major producers.

Subsidies to Iquitos led to the operation of noodle and cracker plant (Fideos Loreta) and a milk and cheese plant managed by Italians. Both of these operations have shut down, due to high costs and the limited market in Iquitos. Except for improvements in communications, economic development in Iquitos has not progressed significantly in the last two decades. Cottage industries have grown, but for the most part only to supply the city. After the cancellation of international flights to Iquitos in the mid 1990s, (which hurt tourism), it was common to hear people say Iquitos was "going backwards". Meanwhile, Loreto has the highest poverty rate (52.8%) of any province in Peru (O'Hare and Barret 1999). Supporting Brown (1988), a crucial economic mileu continuing to face Iquitos is that the small industries there already exist in the city of Pucallpa, its closest trading partner. It is Pucallpa that sends finished products to Iquitos. One saying you hear all the time is that you hear it all the time in Iquitos is that the city "produces nothing except babies." This is not encouraging for an urban center soon approaching one-half million in population[4]. Thus, as Iquitos grows, its capacity to develop industry or improve agriculture in rural areas has been very limited, if not reduced, in recent years. This is in stark contrast to the larger cities of the Brazilian Amazon as reported by Browder and Godfrey (1997). For the new camu camu industry, this situation helps explain why Peru has not been able to satisfy Japanese demands, and is in danger of losing a precious opportunity for economic growth and development in a region where the need for opportunity is great.

A Provincial Mentality

What are the lessons learned from the situation of Iquitos? In this context, the dispersed pattern of establishment of the camu camu fields in the PNCC can be explained in part by the persistent development problems in Iquitos. The uncertainty of events in the city, and the history of weak support for agroindustry no doubt have an effect on planners. Despite their best intentions in developing the plan for the PNCC, they had almost no tradition of creating such plans for rural development with the secure backing of agroindustry in Iquitos. As Freilich (1999) argues, the isolation of Iquitos has created its own culture, a culture that is accustomed to doing things in its own way. An extractivist mentality is still prevalent in the region, and value is added to products elsewhere. For example, tens of thousands of peccary hides are sent from rural areas to Iquitos on an annual basis (Bodmer and Lozano 2001). They are then sent by plane to Lima, and then to Aerequipa, for initial tanning. Peccary hide buyers told me that lengthy route hurt their earnings, and asked me how to get buyers to come to Iquitos. Still, no stage of the processing is done in Iquitos, and no plans exist to do so.

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[4] Efforts at developing and sustaining industry in the small towns of Nauta, Requena, Tamshiyacu and Jenaro Herrera have been mostly failures, except for cottage industries.

After my scores of conversations with planners in the PNCC office, the Ministry of Agriculture, INIA, and IIAP, it seemed that they had assumed that camu camu fruit, with its unique, marketable qualities, now in international demand, would easily find its way from forest and field to buyers, processors, and exporters. It would not be the first Amazonian product to do so. The very nature of extractive "booms" makes people go to the resource. The PNCC turned to extension organizations in Iquitos to manage the planting because they had no other options. Having done so, these institutions would leave their own separate imprints of development across the region (Chapter 3). This pattern may not make much sense to planners elsewhere, but it can be seen as a natural outcome of the recent history of events in Iquitos.

The findings of this dissertation are similar to the analysis of Walker and Homma (1996), which concludes that the complex socio-physical processes of development frontiers in Amazonia show patterns that are at odds with conventional Von Thünen-based prediction. We have learned of some of these differences by examining the initial development of camu camu cultivation and industrialization, and by comparing the situation near the cities of Iquitos and Pucallpa.

The case of the new camu camu industry provides important lessons for planners. What we learn from this study is that the development of the camu camu industry in Loreto and Iquitos may continue to pay a heavy price for the initial lack of planning with respect to logistics and infrastructure. It is ironic that Pucallpa, the one city in the Peruvian Amazon that appears able to accommodate the new industry, was at a disadvantage from the start because most wild camu camu is located in Loreto. Pucallpa has a much more developed industrial base than Iquitos, but it too is located in Amazonia, far from the national markets and ports, both of which are in coastal Peru. Because the Pucallpa processor (Backus y Johnston) incurred such high costs in transporting camu camu pulp to Pucallpa from wild sources, the company converts most of the pulp to powder in order to lower shipping costs by road to Lima and its coastal plants. Unfortunately, this camu camu powder has had little appeal in domestic or international markets, and the company finds itself unable to sell most of it. To offset this problem, Backus and Johnston might be well advised to develop the domestic market for camu camu products.

National Trends and Prospects for the Camu Camu Industry

The case of Iquitos and the PNCC provide examples where overcoming the challenges of a difficult geography, logistics and markets are a characteristic of the Amazon. This raises the question of how the rest of Peru is doing, and if Iquitos is following recent national trends. Many countries in Latin America have made tremendous progress in building infrastructure and undertaking reforms that has facilitated dramatic improvements for investment and trade performance during the last decade. Peru has made progress, but it is one of these countries that have yet to create the necessary conditions for fostering economic growth and competitiveness Thus, we see that problems of development in Iquitos are also exacerbated by a national decline in Peru's competitiveness vis a vis the rest of the world (Schwab and Sachs 2002).

Will the situation in Iquitos improve? To do so, it will have to buck a recent national trend. While Peru has stabilized its currency, improved infrastructure, and increased exports, the country has made most improvements are along the coast, typical for the Andean countries. Such gains are concentrated near Lima, including important recent improvements in agroindustry and fruit and vegetable exports (Breuer 2000, Escobal et al. 2000). It is the interior that is held back. For example, air transport of freight is up during the last decade in Peru, normally a positive indicator of global competitiveness, but in this case because other modes of transport are insufficient or non-existent (Schwab and Sachs 2002). Rather than high-value goods, cargo planes from Lima are too often stuffed with vegetables and other foods. Iquitos is highly dependent on this cargo.

Iquitos is perhaps an extreme case because of national policies and problems. In the last half-century, the region has been resigned to supply natural resources that support development elsewhere (Barclay et al. 1991). Furthermore, the region has been subordinated and dependent upon Lima for far too long. Even in the case of the petroleum industry, it has simply served a "national dispenser" of raw materials for urban-industrial sectors elsewhere in the country (Valcárcel 1991).

From this perspective, it is not surprising that Iquitos remains a backwater of economic development. Small, new industries may be ill-equipped to handle the stringent demands of modern markets for NTFPs (Butler 1992), but the case may also be true for Amazonian *cities* themselves such as Iquitos. Seen in this light, the initial problems associated with the start of this tenuous new industry are more understandable.

Conclusions and Recommendations

Over almost a decade, more than $300,000 in net income was earned by eight rural communities from the camu camu industry. Eighty percent of this came from sales of camu camu fruit, and about 20% came from employment generated by the industry. This was an important supplement to local incomes and it came at a time of the year when sources of cash were scarce or non-existent for these communities. Women and children were especially involved in this new economy. Much more revenue was certainly generated from these three sources of camu camu fruit, and additional research is needed to understand the actual revenue created by this NTFR. This includes transport services, employment in Iquitos, Pucallpa and other cities, and the multitude of transactions which were part of this new industry. Camu camu was also extracted from several areas in the region besides the three sources in this study.

The market value of camu camu was found to be far lower than previous estimates. There is a need to avoid basing market values of NTFPs on retail prices for small quantities. Local communities obtained a higher percentage of the total value of exported camu camu pulp than previous studies show they earn from other NTFPs.

Selling camu camu fruits directly to harvest site purchasers was the easiest way for the ribereños to market the fruit and provided them with the highest returns. If they had to send the fruits to market, this required more effort and resulted in lower returns.

Local patrons often served as middlemen in the marketing of the fruits, which is not surprising given their tradition of managing local extractive economies. More research is needed to understand how middlemen and intermediaries benefit from marketing NTFPs, and how extractors engage with or avoid them. At the same time, there were local efforts to regulate access to wild camu camu, and we may see more of this as communities realize the potential value of this resource. Rural communities located close to Iquitos were able to take advantage of industry demand for their camu camu and manage the harvests, resulting in a more even and sustained income.

Iquitos suffers from extreme geographic isolation and lack of infrastructure. This is partly the result of national policies in Peru. Problems with logistics and the great distances that must be covered to sustain the new camu camu industry have resulted in very high costs and damaged or spoiled fruits. Planners appear to have made little effort to minimize these problems through the cultivation of camu camu with the PNCC. Contamination problems and quality control have severely impacted export opportunities for the new industry, and Japanese demand for the pulp has plunged.

The city of Pucallpa is in many ways better prepared to develop the camu camu industry, although high transportation costs and distant sources of camu camu currently make the business unprofitable. The new camu camu farmers in the Pucallpa vicinity currently have the most stable and lucrative market for their fruit. In the neighboring region of Loreto, an extractivist mentality regarding the economic potential of camu camu still remains strong.

The Peruvian Amazon is characterized by an uneven pattern of development. Iquitos has suffered from recent industrial declines and a lack of infrastructure. This is partly because of national polices. There is a need for peri-urban agrofrestry systems in the Iquitos area, and more effort is needed to promote the cultivation camu camu close to Iquitos. It is too early to tell if these patterns will continue to persist in Peru. Lessons from elsewhere in Amazonia could help Peru in its efforts to improve the links between extraction, production, and markets for the camu camu industry.

The initial “Achilles heel” of the camu camu industry appears to have been the problem of logistics in the Peruvian Amazon and quality control issues rather than the destruction of the resource. Many ribereño communities have enjoyed a brief period of significant economic gain from camu came; i.e., a seasonal “boom”. This commerce has since declined, but there is no reason to think that it will disappear. This initial start to the camu camu export business may in fact reflect a pattern common to other NTFR industries in Amazonia. More research is needed to study the early development of these industries.

It is too early to tell whether the camu camu export industry as envisioned by planners in Peru can in fact become a sustainable industry. The heavy reliance on a single product (fruit pulp) which is dependent on a very limited number of buyers makes this questionable from the start. Without the expansion of markets and cultivation of camu camu, it will be difficult for the industry to sustain itself. Efforts should be made to improve the quality and increase consumption of camu camu products in Peru.

Development of this domestic industry could improve prospects for sustaining exports of camu camu products.

Area	Year	Extraction (MT)	Net earnings per kilo	Earnings from employment (total)	Net earnings to communiites
Jenaro Herrera	1994-98	217.2	.145	19,028.5	70,771.3
	1999-2000	100	.145		
	2001-03	150	.043		
Upper Tahuayo	1994-96	90	.057	857.1	27,757.1
	1997-2001	120	.145		
	2002-03	40	.086		
		10	.043		
		10	.086		
El Estrecho	1998-2000	120	.229	41,143.5	209,043
	2001	150	.171		
		350	.229		
		243.3	.145		
Total		1600.5		61,029.10	307,571.4

Table 7-1. Net earnings from wild camu camu harvests, in US dollars (exchange rate 3.5 to $1). Sources: Field data, Picón and Acosta 2000, Camu Camu Export SA 2001.

APPENDIX A
QUESTIONNAIRE FOR VILLAGE GROUP INTERVIEWS

Name of community, population

Why do people live here?

Three most important reasons? Sources of income?

Is the community growing or are people leaving it?

What about children, and young people?

Do the people work with aid groups or projects?

What projects, for how long?

Do you know what camu camu is? About the market for it?

When did you learn of this? How?

Do you have camu camu? If so, how do you use it?

Do you know what tree camu camu is? Shahuinto?

Would you like to have help to plant camu camu here? Why, why not?

Do people know how to plant camu camu? If so, how do they plant it?

Are there seeds and/or plants for planting it? Where do they come from?

Why did you plant camu camu? Main reasons?

Why did you not plant camu camu? Two main reasons?

Lack of resources? Lack of adequate lands for camu camu?

Unfamiliar with camu camu? How to plant it?

Is there a market for it? If so, how is the price?

How far is the market? Boat fares for passengers, cargo?

What do you grow in low restingas here? Elsewhere?

Do you plant trees here? Types?

What fruits do you sell? Eat?

Do people like to experiment planting different things? Examples?

Are there projects in the community? Aid or credit?

Do people enjoy working in projects? Are they a lot of work?

Was/is there a camu camu project here? Type of help received?

For how long? What were extensionists like? Number?

In what other projects do you work, worked with in last few years?
In the planted camu camu are there pests and diseases? Types?
Do you have access to wild camu camu? Where, when, how?
In the wild camu camu are there pests and diseases? Types?
Is there a lot of wild camu camu here to harvest? Conflicts?
How much do you make for camu camu? Who buys it?
How much can you make in a day? In a week?
During an entire harvest season? When is the season?
Who participates in the harvest? Who are the best harvesters?
Harvest methods? Who damages the trees? How? Why?
What portion of your income comes from camu camu during this time?
What other activities do you do during harvest season?
Problems with harvests? Conflicts? Losses due to high water?
What about harvesting green fruits?
Are the camu camales expanding? Getting smaller, same? Why?
Is there a community management system for the camu camales?
Harvest dates, controlled access, fines, taxes on harvests?
Has the community changed due to camu camu? How? When?
Has community income changed due to camu camu? How? When?
Again, what are the main income earning activities here?
Types of agriculture? Animal husbandry?
Extraction of forest products? Palms? Hunting?
Charcoal making? Timber? Camu camu?
Other activities, wages, trade, work?
Is the community isolated? Why?
Is there school healthposts, infrastructure here? What types?
Why does the community exist, for what reason, when founded?
Other comments, needs, ideas, problems, plans?

APPENDIX B
HOUSEHOLD QUESTIONNNAIRE

Name, age?
Number of children, their ages?
Number of years in the community?
How do you make a living? What are your activities?
Have camu camu planted? Why or why not?
If yes, number of trees? Size of chacra?
Criteria for selecting planting stock?
Distance in minutes of chacra from the house?
When did you plant the camu camu? With what crops?
Do you have other chacras? What do you have?
Upland chacras? Area? Distance from home?
Floodplain chacras? Area? Distance from home?
Is there plenty of land here? Floodplain lands? Uplands?
Is there wild camu camu near here?
If so, do you harvest it? Who harvests it?
Have you ever worked in camu camu? Made money?
Do you plant fruit trees in your lands?
Do you work in other projects? Which projects?

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BIOGRAPHICAL SKETCH

James W. Penn, Jr. was born in February, 1960, in Peoria, Illinois. His parents planted gardens and trees, and were active volunteers in community and civic affairs. For as long as he can remember, Jim was interested in these activities. The family camped frequently, and were consistent supporters of conservation efforts.

Jim graduated from Douglas MacArthur High School in Decatur Illinois in May 1978. He graduated with a B.A. in political science from the Department of Arms Control and Disarmament at the University of Illinois, Urbana-Champaign, in 1983. He then embarked upon several years of volunteer conservation and social work in Latin America, mostly in Peru, where he is still active in these activities. Jim received an M.A. in Latin America Studies from the University of Florida in 1999.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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This dissertation was submitted to the Graduate Faculty of the Department of Geography in the College of Liberal Arts and Sciences and to the Graduate School and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

August 2004

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